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THE AMERICAN SOCIETY OF NATURALISTS

SYMPOSIUM ON THE SCOPE OF BIOLOGICAL TEACHING IN RELATION TO NEW FIELDS OF DISCOVERY

FROM THE STANDPOINT OF A ZOOLOGIST

THE speaker must admit that upon taking time to reflect on the various ramifications of the subject announced his first reaction was one of wonder at himself for ever having agreed to enter into such a discussion; for obviously any statement must be the expression of a personal opinion influenced largely by the advocate's own training and the conditions which obtain in his local institution.

Upon roll-call one finds oneself confronted by such lusty newcomers as: ecology, animal behavior, comparative and general physiology, biochemistry, cytology, genetics, biometry, which, however, is really a method of work and not a special field of investigation; experimental zoology, a sort of general mélange which also includes some of the more special fields enumerated; experimental embryology, a subject inextricably interwoven with experimental cytology and which in recent times has sported a new offshoot—tissue-culture in vitro—already almost an ology in itself; not to omit such important applied subjects as parasitology, protozoology and the application of biological principles to human problems.

How much are we justified in letting these replace our traditional general zoology, invertebrate zoology, comparative anatomy of the vertebrates, histology and embryology? One realizes vividly the just merits of the new claimants, but when he faces the problem of deciding as to which

of the older subjects they shall supplant, he can not but hesitate. Which of these true and tried teething-rings of our zoological infancy shall be discarded? Can we spare any of them? I must confess that after considerable pondering I have concluded that for the training of the professional zoologist or the teacher of zoology I do not see how we can. I can find ways for shortening them to make room for new subjects and ways for injecting new meanings into them from our late fields of discovery, but it seems to me that when all is said and done, comparative morphology, including embryology, together with some histology, is a well-nigh indispensable ballast for our ship of biological progress. None of the newer experimental lines can yet take the place of these for training the zoological apprentice. I have yet to find the subjects in which I can pin my students down to exact observations, unequivocal inference and far-reaching generalizations in the concentrated form I can secure in a course of study based on morphology, but saturated throughout with demands for interpretation of the structures under consideration in terms of function and environment.

It seems to me, moreover, that nearly all of these newer lines actually or tacitly presuppose a considerable amount of systematic or morphological training. Much of our experimental zoology has bearings on the problems of evolution; hence what can such work mean to a student who has not reached an understanding of organic evolution from a careful comparative study of animals of different degrees of complexity? Or of what avail are many of the efforts of our statistical friends, the biometricians, without a keen appreciation on our part of the questions at issue, based fundamentally on an understanding of the real significance of variations? Or in the realm of animal behavior, one of the insistent new claimants for attention, the facts have meaning mainly as interpreted from the comparative or the evolutionary point of view, which presupposes knowledge of the relative complexities of the fundamental types of nervous systems. Of what significance, for example, is Professor Jennings's trained starfish, except as understood in terms of our knowledge of the starfish nervous system and the animal's relative position in the animal kingdom?

Or, taking the field of experimental embryology, how far should we get in true scientific appreciation of the recent work on tissue culture in vitro had we not considerable preliminary familiarity, not only with the structural nature of tissues but with general embryology as well? And when it comes to the quest for organ-forming substances, cytoplasmic prelocalizations or whatever we may be disposed to call precleavage differentiation, certainly the neophyte can travel the road towards understanding but a short distance without considerable preliminary knowledge of organogeny and even of cytology. Or again, in the field of genetics, while some of the practical values may be understood and utilized by those having meager knowledge of other biological facts, the full appreciation of the new discoveries can be grasped only by the well-rounded student, conversant with modern points of view in the fields of variation and evolution, embryology, cytology and general zoology.

Coming to cytology, no one, I think, will gainsay the statement that it is highly desirable for students to have had preliminary courses in comparative zoology, histology and embryology, to say nothing of a grasp of the problems of heredity and variation.

At the very outset of our planning, of course, we are met with the question, which of our students are we planning for? The five or ten per cent. who may become pro-

fessional zoologists, the somewhat larger proportion who are going into medicine, or the vastly greater proportion who are going to take only one, or, at most, two or three courses as part of their general education? Personally, after experimenting with various plans for different classes of students, I have reached the rather settled conviction that no matter what the later work of the students is to be, they may all profitably be subjected to the same first-year course; namely, a course which will give them a good perspective of the whole field of zoology, old and new, and which emphasizes general principles rather than morphological detail, though by no means ignoring the essentials of morphology, or in other words, a course arranged for principles and not primarily for types.

I think there is particular danger of the specialist letting his specialty obsess him to the disadvantage of his general introductory course. Even though facts are formally true in themselves, the student may be given an entirely erroneous view of the whole, if the facts emphasized are the less important components. To an entomologist all zoology may lie in the realm of the insect, or perhaps of even some particular group of insects; or, if a specialist in fungi, all botany centers, perhaps, in the toadstool and its anemic brethren; or if a cytologist, the student may hardly be led to realize that there may be something in the world of life worth studying that does not lie under a cover-slip. I thoroughly sympathize with the heartfelt cry that heads the title-page of a recent elementary text-book in botany, "More about hay, less about karyokinesis!"

The general course I have in mind, though omitting much of the technical detail that a professional zoologist must acquire, nevertheless should give the prospective specialist such an orientation in the whole field of his science as is almost indispensable for balance and which in all probability he will not get in any of his later courses. At the same time it must give the general student an intelligent insight into the real live problems of zoology and should tempt him to venture further into some of the special phases of the work which appeal to him. The laboratory work of this introductory course should, in my estimation, be a study of various animals in all their life relations, with a constant demand on the student for interpretation, not merely corroboration of anatomical and morphological descriptions. The forms should be selected to illustrate general principles of physiology, environmental relations, evolution and genetics as well as phylogenetic position. They should also introduce the student to the fields of embryology and histology. In our own university we have found a series consisting of the frog, ameba, paramecium, euglena, volvox, hydra, gonionemus, crayfish and bee to answer our purposes very well as an introduction to general principles in a one-semester course, although we prefer to have our students take a second semester of zoology supplementing the general work by additional forms taken partly from the same but mainly from other phyla of the animal kingdom.

The frog is admirably adapted to the elucidation of general principles of morphology, physiology and ecology, and also furnishes excellent material for an introduction to embryology and histology. In our own laboratory we devote a total of some fifty-six hours of work to the frog. We find it a decided advantage to begin with a form sufficiently large that every student can get to work on it during the first ten minutes of the first laboratory period. Having begun with a larger form, all will not come to the microscopical work

and require assistance at the same time. The transition from the histology of the frog to the amœba is a simple one, and in the succeeding series of forms we get not only more or less of a gradational morphological sequence which will give the student some idea of evolutionary progress, but a good series for the introduction of the ideas of animal behavior, differences between plants and animals and other fundamental problems. For instance, in volvox we see the beginnings of the body as distinct from the germ, and it affords a splendid opportunity for introducing ideas relative to germinal continuity, evolution of sex and the like. *Hydra* and *Gonionemus*, besides opening the way for the conception of metagenesis, illustrate the simpler principles of differentiation. The frog, crayfish and bee, when contrasted in their structural adjustments to environmental conditions, give an excellent selection for showing diverse means of meeting the same fundamental problems of existence. Lastly, the bee is excellent for guiding the student into the problems of genetics. I find that the single query in the laboratory outline as to how, inasmuch as the workers are sterile, their various characteristics are passed on to the next generation, is more serviceable in opening up to the student the real underlying problems of heredity than a considerable amount of mere lecture declamation on the subject would be.

From the first year on there will be a divergence among the students, depending upon their future intentions. Many will never get beyond the first course. On the part of general students, however, I find a strong and increasing demand for at least one or two additional courses which will afford them greater opportunity to get the bearings of biological principles on human problems. I think it can be justly urged, therefore, that this applied phase of the work is worthy of a modest course somewhere in the departmental curriculum after the first year. If "the true study of mankind is man," certainly the most promising approach to this study is through biology. Our social and educational problems have suffered too long already at the hands of the biologically untrained. I suspect that to the great majority of our students who will never become trained zoologists there is nothing of greater value we can give them than a clear-cut biological orientation towards the problems of human life. Train such students week by week and month by month in scientific discrimination and in the handling of biological evidence secured by their own efforts at observation, and we shall contribute to society fewer victims for the demagogue, the sensationalist and the charlatan.

Of all people, the prospective teacher and the social worker need the vivid knowledge of facts concerning living things that can be gained only by direct contact with the objects themselves, yet how few of either of this class ever get more than the colorless remnants of biological truth that may be gained at second hand through the paths of pedagogy and sociology! Many professors of pedagogy and sociology are coming to realize the importance of preliminary biological training for their protégés, and, although themselves biologically untrained, are endeavoring to make good the deficiency. While one sympathizes heartily with the feeling of necessity which prompts their endeavor, he can not but marvel at some of the biological rag-time effects not infrequently served up in these fields as biological truths.

How many teachers have an adequate understanding of the functional adjustments necessary to normal activities in either simple or complex animals? Yet, lacking this, how can they be expected to

prescribe for the imperfect mental or physical adjustments of their charges, to establish habits of thought or behavior, to correct defective habits by developing compensatory ones, or to lay down guiding principles for the most efficient furtherance of normal functions?

Or, to turn to the matter of natural endowment, how many of them realize that what a child becomes is determined in great measure by its inborn capacities and that education consists largely in applying the stimuli necessary to set going these potentialities and of affording opportunity for their expression? That of the good propensities some will require merely the start, others will need to be fostered and coaxed into permanence through the stereotyping effects of proper habits; that of the dangerous or bad, some must be kept dormant by preventing certain kinds of stimulation, others repressed by the cultivation of inhibitive tendencies, and yet others smothered or excluded by substituting in their place desirable traits? And yet if they are ignorant of all this are they not pretty much in the position of one who would attempt to operate a complicated engine without any understanding of its mechanism?

In this whole matter of human heredity, or eugenics, clearly the biologist is the one to lead the way, and yet we find this field being exploited by all sorts of impossible fanatics and incompetents. In spite of the badinage of the press and the confusion resulting from its use of the term eugenics in many senses, nearly all of them equally wrong, the science itself has come to stay, and the public, sensing the vital truth at bottom of it, is going to demand more and more enlightenment. Surely if anywhere we need here to guard against the ambitious enthusiast who promises the impossible, who, for instance, at one sword thrust would stay the demon of degeneracy and restore a sort of pristine purity to the human race. And yet how is the public to be guided aright unless biologists, the ones most competent to advise, step forward and keep them in touch with the more solid advances which are being made through the sure though unspectacular methods of research?

In our own institution I find a strong demand on the part of general students for at least an additional lecture course in genetics with emphasis on the eugenic phase. Some take the elementary embryology as a sort of laboratory course to accompany the work and it seems to me that this is a combination to be commended. I see no reason, moreover, why such students should not be encouraged to take, as many do with advantage, courses in ecology, animal behavior, elementary entomology or parasitology, according to their taste, even though they do not take the regular courses in invertebrate zoology or comparative anatomy which personally I feel are well-nigh indispensable to those who expect to teach zoology or become investigators.

But how, it may be urged, are we to find a place for the new subjects if we are still to retain our traditional courses? Will these not occupy quite all of the time that can be devoted to zoology?

One way to gain considerable time is to shorten some of these older subjects. This can be done without sacrifice of thoroughness on the part of the student, it seems to me, by dissecting fewer forms in detail and using the remaining forms largely for the study of the more significant features in which they are different. Why, for instance, have the student dissect out in minute detail the arterial system of the dogfish, perch, necturus, turtle, pigeon and cat when a careful dissection of this system in the dog-fish, necturus and the cat, together

with a comparatively brief study of the corresponding systems in demonstration specimens of the other forms, will give him the necessary experience, knowledge and perspective to serve the full educative value of the work?

But does this advocacy of retaining the old standbys carry with it the corollary that they are to be taught in the same old way, from the same old malodorous specimens, and from the same old standpoint? By no means. There is such a thing as letting nearly all of the newer fields enter into the traditional courses to vitalize and illumine them while at the same time retaining their valuable disciplinary and informational features. We need not replace or dilute, but rather compress more of value into these courses by insisting on ecological and physiological along with the morphological and evolutionary interpretations. A frog, for example, is interesting enough as a piece of architecture, but it becomes many times more interesting when we advance to its interpretation as a machine constructed for the performance of a wide range of life activities. When the student examines our selected types of animal machines in the laboratory he should be made to realize that he is not only to interpret their respective structures as so many intergradients in an evolutionary series, but that he is also to explain the mechanism in each case in terms of function and adjustment to environment. What a given structure accomplishes and how it does it, what its efficiency is as compared with other types, is of fully as great importance as how, from the evolutionary point of view, this or that organ has advanced or regressed over the corresponding one in some other animal. Omit either kind of interpretation and the student has been deprived of valuable insight that he might have had with very little additional effort. It may seem banal even to call attention to this obvious fact, but visit the average laboratory or look into the laboratory manuals in common use and one can not but feel that this evident fact has been almost entirely ignored.

I think there is a nearly universal feeling to-day that we have been too closely wedded to structure and have wrongly divorced it from function and environmental adjustment; our convictions, however, find but tardy expression in our manuals and laboratory directions. Part of this situation is undoubtedly due to the inertia of routine. It is much easier to realize that another system is better than actively to break with traditional texts and guides and rearrange our work in harmony with our new ideals.

Supposing that I had a free hand to arrange a curriculum for a zoological department according to my own feeling of what would turn out a well-balanced student to undertake graduate work or to become a teacher in secondary work, I should plan about as follows: a two-semester course in elementary zoology of five credit hours per semester; a one-semester course each in invertebrate zoology, comparative organology of vertebrates, embryology and histology, omitting, if anything, the histology. Into all of these I would inject as much of the living animal and of experimental processes and interpretations as was at all practicable; that is, I would have these fundamental courses morphological but shot through and through with interpretations of functions and adjustments.

Finally I should want to see offered such additional courses in animal behavior, ecology, cytology, experimental embryology, general physiology, genetics and other special subjects, as the abilities and tastes of my departmental colleagues and myself would warrant.

As for graduate students it seems to me that since they are presumably mature individuals with thorough preliminary training in the main zoological subjects, one of the important things to do is to wean them away from mere course taking, a habit with which they are usually obsessed, and head them into problems and seminaries. If their preparation is inadequate let them take courses open to advanced undergraduates but strictly graduate courses can, I believe, be advantageously restricted to a few lectures per week in various special fields.

Being mature, the graduate student may well be expected to get much of his information by reading for himself. By way of suggestion I would give him a memorandum to the effect that it goes without saying that in addition to his more technical pursuits, every candidate for the doctorate will be expected to know modern evolution problems; the generally accepted views on phylogenetic relationships and the validity of the criteria on which these are based; and the elements of animal behavior, genetics and developmental mechanics. A suitable list of special references for study in these fields would be appended.

Furthermore, for the purpose of broadening his interests and cultivating a sense of proportion, each candidate might advantageously be given a list of fifty or more books that he is expected to have read before he completes his work. This list would include mainly the general classics of the subject in various departments, such as voyages, travels and explorations; history; biography; a few special memoirs; general principles; a few works of the better literary naturalists; and some of the more general works in special fields.

In conclusion I should say, then, that I see no need of abandoning our general zoology, comparative anatomy, invertebrate zoology, embryology and histology courses in favor of the newer biological sciences, though we can perhaps advantageously shorten them to make room for courses in the new subjects and we can pervade them all more or less with the method and thought of the newer work. If in these fundamental courses we will but put life back into our laboratory specimens, life into our method of offering them as subjects for thought, and life into our students by forcing them into the interpretative attitude of mind, then I think we shall have gone far toward introducing our charges to much that is significant in the newer fields without sacrificing the well-recognized values of the older discipline.

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FROM THE STANDPOINT OF A BOTANIST

THOSE of us who are possessed of a conservative temperament may be inclined to look askance at the newer fields of investigation, or to doubt their value for educational purposes. If so, we need merely to consider that not many years ago science of any kind was not regarded as a suitable subject for school or college. Moreover, the sciences themselves have undergone a marked evolution. The earliest biological studies were descriptive and enumerative; then came the study of internal structure, followed in its turn by the study of function, environment and inheritance. To an outsider it looks as though the subject of entomology were still largely in the taxonomic stage of development, which is not to be wondered at when one recalls that over half the species of animals are insects.

Instruction in biology has likewise exhibited an evolution; it no longer consists wholly or even largely of systematic work. Botanists still do a certain amount of "manual labor," but fortunately we have passed out of the period when first-year

botany consisted in a study of Gray's Manual, and the second-year botany of more Gray's Manual. Botanists have traveled a long way from the ideal of Linnæus, who declared that the only worthy task of a botanist is to know all the species of the vegetable kingdom by name. Thus progress has been the word in biological teaching, but, as has been the case in education in general, fads have crept in and have usurped the place rightly belonging to less spectacular but more fundamental aspects of the subject. One of the most pernicious of these in the recent history of botanical instruction is indicated by the flood of elementary text-books on so-called practical botany, in which there is very little botany, but a good deal of elementary forestry, horticulture, plant breeding and the like.

Since all of us specialists are faddists in a more or less worthy sense, we run the risk of introducing our favorite topics into our courses, and even giving them undue prominence. Moreover, we may experiment on the matter and method of our courses, while quite alive to the danger of riding our hobby in the lecture room. It will probably be agreed that the course which is most important from the standpoint of pedagogic experiment is the introductory course—general biology or general botany or general zoology, as the case may be. In fact it may be said that the crux of the question lies here, for if it can be decided what is to be the content of this general course the more advanced courses will readily fall into line; the character of the latter will be largely determined by the special needs in the particular institution; for instance, the course in plant pathology which would be required in a college of agriculture would naturally be represented in a less technical institution by an advanced course in fungi. Further, the general course includes all the biology which many students get, hence this course should be organized with particular care.

Coming then to the consideration of the general course, a study of curricula shows that there is a marked lack of unanimity among biologists as to what should be its content, and this fact causes no surprise, but is entirely reasonable in view of the diversity in needs of students. The lack of uniformity which courses exhibit arises from selection of material, for in a field so vast one can scarcely hope to treat the whole, even in a general way. If such should be attempted, we encounter at least two dangers: first, a topic must be treated so briefly that students fail to comprehend it. Any one who has tried to make Mendel's law clear to a freshman class will appreciate this statement. Second, when the student begins more advanced courses he loses the advantage of entering distinctly novel fields—we have already sucked the juice out of the orange, so to speak. But if the whole subject may not be covered, it becomes necessary to select, and continued selection through a period of time has resulted in the survival of the fittest, that is, the assembling of a number of topics which may be regarded as fundamental. These topics in a well-ordered course represent principles, for the plants or animals studied are not introduced for their own sake, but in order to illustrate one or more principles which it is desired to teach. Thus a liverwort may not be of great importance on its own account, but it illustrates alternation of generations and the probable origin of a land flora, and hence properly finds a place in a general course.

When a new field of discovery supplies facts which make a claim for introduction into the general course, they must justify the claim, lest we crowd out the tried and proved to make room for the new. The significance and value of a new fact may

be tested thus: how does it react on the already ascertained body of facts? Does it essentially modify what we have come to regard as fundamental concepts? The answer to these questions will go far in determining whether a new fact or theory shall find a place in a general course. Judged by this criterion, paleobotany has won for itself a place in any course where the relationships between plants constitutes one of the fundamental principles. Not that paleobotany needs to be introduced formally under that designation, but fossil plants may now be dealt with in an evolutionary scheme in the same way as existing ones, and our view of the plant kingdom as a whole is correspondingly broadened. To quote D. H. Scott: "Our whole conception of two at least of the great divisions of the Vegetable Kingdom—the Pteridophyta and the Gymnosperms—and of their mutual relations, is already profoundly influenced by the study of the ancient forms." In a similar way recent progress in plant anatomy has so far established a new point of view that its results must be incorporated in all but the most elementary presentation of the subject of morphology.

But there are other ways in which a new topic may justify its claim for insertion in a general course. The new facts may have such intrinsic and fundamental importance that they may fitly find place in a course, although not reacting to any considerable extent on the older material. In this way the leading facts concerning inheritance may justify the place they hold in some general courses. A real difficulty in including this topic arises from the fact that freshmen lack the antecedent training in cytology and embryology which is desirable before one can really grasp the principles of heredity.

A principle which must not be lost sight of in deciding for or against a new topic is its pedagogic value. New subjects suffer in this respect from their lack of organization; they consist largely of a number of interesting and significant observations, but these are at first unrelated, and therefore of inferior value for teaching purposes. A good example is seen in the mass of facts which is accumulating as the result of the activity of workers along Mendelian lines. It has also been noticed that speculation has run far in advance of these facts —an observation which carries its own moral. Plant ecology is another branch of the subject which lacks organization. As Cowles has said, until recently ecology had no fundamental concepts. Moreover some of the workers who have rushed into this field have not hesitated to provide a plausible explanation for every phenomenon, with the result that careful work has been discredited along with the hasty. We should beware of the attitude of mind which leads us to explain everything. We have abundant reason to consider this matter of pedagogic value, for we must realize that sciences and especially the biological sciences are still on trial as subjects suitable for schools and colleges, and that some disappointment has been manifested at the results following their introduction. All sciences still suffer from a lack of the definite organization which has long been possessed by the classics and mathematics. Biology is indulgently tolerated by the followers of the more exact sciences; in the words of one of my engineering colleagues, "biology is largely an observational subject." Hence we do well to be sparing in our introduction of new and unorganized branches of our subject. We are in danger of sacrificing a training in exact thinking, such as is provided by comparative morphology, and gaining only intellectual haziness. That this is a prevalent and serious defect in American education is

borne out by the report of Oxford tutors concerning Rhodes scholars; the tutors readily admit the mental alertness of the American scholars, but uniformly remark upon their inability to settle down to do a long spell of thorough work.

Again, since we very properly lay more stress on nature than on books, the availability of a new topic for laboratory purposes must be considered. It is a matter of common experience that morphological work presents fewer difficulties than any other when unwieldy classes have to be marshalled section after section in overcrowded laboratories. Unless numerous assistants and abundant laboratory and greenhouse space are available, work along physiological, ecological or genetic lines is apt to result in much waste of time and few profitable results, while at the same time the student is missing the opportunity of laying a stable morphological foundation for his later studies.

Even when the best word has been said in behalf of the newer fields, the preeminence of morphology as the *sine qua non* of instruction remains untouched. Though the educational pendulum may swing far to the right and left, it returns to its stable position, and that position points to morphology. One of the dangers which a student encounters is that of specializing too early, before he has laid a solid foundation. Hence our general course must show a preponderance of that branch which experience has shown to be fundamental. Examples of the fatal consequences of an absence of adequate knowledge of morphology are not hard to find. On the botanical side we need only recall the blunders of the earlier paleobotanists, who framed phylogenies based on external structures only, and in our own day we have the sorry spectacle of experimental morphologists who have a slender grasp of morphology, and of plant physiologists who propose theories which are at once seen to be untenable when viewed in the light of the elementary facts of histology. Work in genetics or in plant pathology carried on by those who are not rooted and grounded in morphology is bound to be of the empiric type, too greatly resembling the product of the short courses in agriculture.

What then shall be the nature of the well-ordered general course? Since a paper such as this is more or less the writer's confession of faith, I may as well conclude by telling what we are attempting to do in the institution which I represent. First, the course is one in general *biology*, in which the professors of botany and zoology lecture in turn, each completing a topic before giving place to the other. During the greater part of the year the morphology of the two kingdoms is developed, but each form selected for study is considered not on its own account, but is introduced in order to illustrate some fundamental principle. Form and function go hand in hand, each supplementing the other. Thus the course is strung on an evolutionary and also a physiological thread. Any form which does not fit in with this scheme is ruthlessly weeded out. At suitable times general topics such as evolution, heredity and certain ecological themes are formally treated. Laboratory work for the most part follows the order of topics adopted in the class-room, but while human physiology is being considered in the class-room the class is dissecting the frog in the laboratory.

Realizing that it is somewhat presumptuous for one man to speak for all botanists, I have sought the opinion of a botanist who has had long experience in teaching, Dr. John M. Coulter, and have been pleased to find that his view of the subject matter of an elementary course pretty closely cor-

responds with the one expressed in the foregoing. I take the liberty of quoting:

I should say that the elementary course or courses in botany should always be synthetic. Fundamental in the synthetic presentation of botany I should say is morphology, for I do not believe that any effective work can be done without some knowledge of the structures involved. Then I should say that the morphological thread that runs through the course should string together the most important physiological phenomena as explanations of morphological structure. In fact, I would not regard any morphology as significant that could not be explained in terms of physiology; and on the contrary, I would not regard any physiology as worth while that could not be fitted into morphological structure. In other words, I can not divorce the machine from its work. Naturally in this statement ecology becomes merely a form of physiology. This would be my general notion as to the content of an elementary course in botany.

What should be given afterwards depends entirely upon the size of the botanical staff and its differentiation in interest. After the synthetic course, I think there should be opportunity to develop morphology, physiology, ecology, etc., independently. Of course, experimental morphology should come in as a hybrid between morphology and physiology. I should say that genetics would come after almost everything else.

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EXPERIMENTALISM IN ZOOLOGY

THE followers of science have shown at all times a marked disposition to readjust the style of their intellectual apparel to new conditions, and in this respect the zoologist is no exception. There are some among us who still prefer to appear in the ancient and respectable mental garb of the systematist, others who adorn themselves in the Empire costume of the comparative anatomist, and still others who have put on the Victorian attire of the embryologist. But he who wishes to be truly modern is content to clothe himself in only the scanty raiment of the experimentalist. A glance at this last class shows it to be made up of the young and the would-be-young. This latest style, unlike its predecessors, is not a creation from Paris or from London, but is largely a home-product, the result of what its inceptors would call internal factors, those conveniently vague things about which we know so little. Although we are not wholly clear as to the process by which we have come to be experimentalists, we are convinced that it depended upon something like an irreversible reaction and that we have come to stay.

The experiment, however, is by no means a modern invention. As early as the thirteenth century Roger Bacon was proclaiming to unsympathetic scholars its soundness as an instrument for the discovery of truth. In his opus majus he maintains that

There are two modes of knowing; by argument and by experiment. Argument concludes a question; but it does not make us feel certain, or acquiesce in the contemplation of truth, except the truth be also found to be so by experience.

And still farther on in the same work he declares that

Experimental science, the sole mistress of speculative sciences, has three great prerogatives among other parts of knowledge: First, she tests by experiment the noblest conclusions of all other sciences; next, she discovers respecting the notions which other sciences deal with, magnificent truths to which these sciences themselves can by no means attain; her third dignity is, that she by her own power and without respect of other sciences, investigates the secrets of nature.

Although Roger Bacon's utterances in favor of experimental science were made over three centuries before the days of his illustrious fellow countryman, Francis Bacon, and at a time when such utterances were dangerous, they were by no means the earliest expression of the experiment. Some sixteen centuries before Roger Bacon's time, Aristotle wrote in simple language an account of what is probably the

earliest recorded biological experiment. It deals with the physiology of the senses and reads as follows:

> By crossing the fingers a single object under them appears to be two and yet we do not say there are two; for sight is more decisive than touch. If, however, touch were our only sense, our judgment would declare that the single object is two.

Thus Aristotle employed the experimental method for the discovery of truth. With all this history behind us it may seem strange that we have been so slow in appreciating the significance of this method. But it must be remembered that the biological sciences, unlike physics and chemistry, have had an enormous volume of descriptive material to handle, and that it was only after this task was well under way that really fundamental problems could be attacked. It is also to be kept in mind that such sciences as chemistry and physics have begun to yield only recently results and methods which have been of direct service to biology. Viewed from this standpoint the whole course of development of the methods employed in biological research is a natural one, and, though we may not fully appreciate all the steps by which we have reached this new road to discovery, we are persuaded that the course we have taken is the result of the untrammeled growth of our science.

With the acceptance of the experimental method as a part of the means of biological research comes the responsibility of training students in the new way of work. To those of us whose zoological apprenticeship centered round the paraffin bath and the microtome, this is no simple proposition. With little physics, less chemistry, and almost no mathematics we find ourselves poorly equipped to meet the new emergencies. One of my colleagues trained in this fashion seems never to appreciate the fact that there is a third dimension in space, and in my case mathematics is metamorphosed from one of the most exact forms of expression into one of the most inexact. Although we may take consolation in the fact that even so illustrious a physicist as Faraday was essentially unmathematical, we can not look upon the deficiencies that I have just pointed out without recognizing that they are real shortcomings. These defects in our early training can not be ascribed to lack of reasonable foresight on the part of our teachers or even to our own idleness. They are the natural result of the prodigious rate at which our science has been growing, a rate that made it impossible for even the best informed of a generation ago to predict the needs of today. This is true not only of the present, but also of the past. Darwin's early training was that of a physician, and Huxley actually went into medical practise. Both men in their early days never entered a biological laboratory, for the obvious reason that no such institution existed, and both regretted their educational deficiencies.

Inadequately trained ourselves, how are we to meet the problem of training others in the new directions? The situation seems to include to a certain degree the impossibility of lifting oneself by one's boot-straps. But I suggest that while tugging at the straps a slight jump will lift us a little, and the jump that seems to me to be advisable is to recommend that our students pay more attention to chemistry and physics, sciences in which the experimental method is well developed and which are yielding results that are applicable more and more to the fundamental problems of biology. Such a training, when rigorously pursued by a student with a clear understanding of its relations to biological work, is bound to be richly productive as soon as it is turned in the appropriate direction.

But physics and chemistry are, in my

opinion, only part of the preliminary scientific training for these new lines of work. The zoologist is continually confronted at least in his study of the higher animals with those complicated conditions that we recognize in our own mental states. That such conditions exist in varying degrees in the lower animals no one can deny. The questions that arise concerning them are what is their nature and to what extent are they present in the lower forms. These problems are psychological, and I should, therefore, regret to see a prospective zoologist omit from his preliminary training a reasonable grounding in this field of investigation. In one way, however, I regard psychology as less important for the beginner than physics and chemistry. In it the experimental method is less completely developed than in the two sciences just named. In truth, it is in this respect much like biology itself and in need of help especially from the side of chemistry. The genius of Helmholtz seems to have had such an overwhelming influence on most psychologists that they have been content to study almost exclusively the physics of sensory phenomena to the neglect of other psychological fields, such as the chemistry of the central nervous states. But though psychology may have its own difficulties, I nevertheless regard it as a field that should be included in the general training of every student who aspires to a broad-minded and productive scholarship in zoology. With the botanist it may be different. He sometimes counts himself fortunate to have escaped the problem of mind, but to my way of thinking this very problem is one of those elements which makes zoology so intensely interesting.

But the young zoologist trained in the experimental method by physics and chemistry, and heedful of the fact that the material of his investigation may exhibit among its characteristics some of the phenomena of intelligence, must still assume a very different attitude toward his work from that which most of us were accustomed to in the laboratories of twenty or thirty years ago. Those were the days of morphology, when the visible structure of the organism was all important and the problem of the homology of various parts, the integrity of the germ layers, and so forth were of foremost interest. The attitude of the average student of those days was essentially anatomical, and the anatomical conception of an organism was that of a standing motionless object. Immensely important as this view was, it lacked the really essential characteristic of the living thing, its incessant activity. The new view, on the other hand, includes just this feature. The student of thirty years ago was concerned with methods of preserving animals and he never felt safe until his catch was in the alcohol jar; the modern student is all alert to keep his stock alive and he consigns it to preservatives with funereal rites. This change in attitude is part and parcel of the new growth and is working a slow but steady revolution in the equipment of our laboratories.

With all this overturning and revolution going on in our advanced work, what can we say of our elementary instruction. Here we are supposed to keep to those aspects of the subject that are well established and that are not open to fundamental revision. Moreover, in this direction the procedure of lecture work and laboratory routine is well established in text-books and the like, and the instructor, in keeping in these well-worn paths, is on what seems to him to be safer grounds. But even the elementary courses, in my opinion, must not be devoid of promising outlook. They should include a reasonable amount of the new work. But to accomplish this without printed

guide or previous training is not an easy task for the older teacher. Here is perhaps the point in the new work at which the young and the would-be-young are most clearly differentiated. To me the contemplation of this subject is embarrassing and I pass it by. But for the encouragement of those who are in my plight, I must add a word from my own experience.

I believe that some of us who are older teachers fail to appreciate, from our disinclination to give the matter a trial, how easy it is to arrange elementary courses, especially the laboratory exercises in such courses so as to illustrate animal activities by the experimental method. I know that in my own experience a laboratory course which I gave to high-school teachers a year or so ago was in this respect immensely illuminating. I had no idea that the new methods could be applied so directly. To give some notion of the nature of the work that can be carried on in such courses let me name some of the exercises that we found serviceable: the effects of light on the movements of planarians, earthworms, mealworms and the larvæ and adults of flesh-flies; the combined influences of gravity and light on the movements of fruit-flies; the effects of odorous substances on the movements of earthworms and on the gathering of fruit-flies; the feeding reactions of planarians, catfishes and toads; the means of locomotion in earthworms, mealworms and snails; the reactions to stimulation in paramæcium, and its rate of reproduction; regeneration in planarians and earthworms; heredity in fruit-flies. These and other like exercises were found surprisingly applicable to elementary work and have encouraged me to believe that practise in experimental work may well be introduced into elementary courses.

Such work, moreover, is not without its beneficial influence on the teacher. No two animals are ever alike in their reactions, and in this respect they differ vastly more than they do in their structure. Although each exercise can be made to lead to a general conclusion for all students concerned, the details of the work soon come to be individual. The instructor is called upon, therefore, rather as an adviser in method than an authority in facts, and from this standpoint his attitude toward his work is much more natural than what it often is in purely anatomical exercises. Woe be to him if he begins to tell what a given animal at a given moment will do! I know of no elementary biological exercises that are better adapted than these to develop independence and originality in the student and to reduce the instructor to his true position, that of a student of greater maturity than those about him. As a result of this experience, I look with great hope on the steady introduction of experimental exercises into our elementary work. Certainly the conception of an animal that is gained from work such as this is much nearer the truth than that which we have been instilling through alcoholic specimens.

But if these are the realities of the experimental method, what are its vanities? I think the chief pitfall that besets the experimentalist is apparatus. What a strange allurement this feature of the situation has for us! What can be more pleasant to the eye than beautiful apparatus in glass cases or a grand array of delicate contrivances built up upon a table! And they are always so interesting to the visitor! But I shall never forget the comment of a friend of mine who on looking over an extensive device of my own construction finally remarked that the justification of such work as biological did require a goodly supply of brass. But if apparatus is our pitfall, we must remember that many of the pioneers in the new movement have

already demonstrated to us fundamental results by means as strikingly simple. To Loeb the problem of the universe is soluble in a finger-bowl; to Morgan in a milk-jar; and we must never forget that the importance of a result is often inversely proportional to the complication of the apparatus by which it was attained. With these examples before us, let us avoid the pitfall of bright glass and shining metal.

I have entitled this paper "Experimentalism in Zoology" and I have nowhere used the term experimental zoology. This has been intentional, for I do not believe in this term. The new movement does not mean a new province in zoology; it is a new method of attacking old problems. It will, of course, lead us to new fields, but it is method rather than matter. We are not exchanging old lamps for new but burning the old lamp in a new way. I therefore resist the term experimental zoology. We are all still zoologists and we have simply added to our equipment the experimental method. As each one, old or young, realizes the significance of this method and the great power that it puts in his hand, he will adopt it in proportion to his needs and abilities. In this way it is gradually pervading the whole fabric of biology from the realm of the systematist to that of the ultra-modernist. Our times are full of such changes. To-day we men vote, to-morrow our women will vote. Let all such changes come as natural growths.

G. H. PARKER

HARVARD UNIVERSITY

THE PRODUCTION OF RADIUM, URANIUM AND VANADIUM ORES IN 1913

PROBABLY no other mineral is mined which has so large a hold on public attention and at the same time has so small a total monetary value as the uranium minerals. This interest is, of course, due not to the minerals as such, nor to the uranium they contain, but to the accompanying radium, which is found only with uranium. Hitherto the interest in radium, though lively, has been largely academic, on account of the marvelous qualities which it displays when compared with better-known elements. Toward the end of 1913, however, public interest became almost feverish, owing to the apparent cures of cancer wrought by the application of the gamma rays given off by radium.

Uranium minerals were produced in commercial quantity in the United States in 1913, as shown by preliminary statistics gathered by Frank L. Hess, of the United States Geological Survey, only in Colorado and Utah, and although during the year some pitchblende was mined in Colorado in the Belcher & Calhoun mines, only a few pounds were sold, though 50 dry tons of low-grade material carrying 1.49 per cent. uranium oxide (U_3O_8) was shipped to France from the Kirk mine. This had been mined a previous year. Carnotite, a yellow powdery or waxy mineral found in the sandstones of the high plateau between the Rocky Mountains of Colorado and the San Rafael Swell of Utah, south of the Book Cliffs, furnished the whole production.

Carnotite, as the word is ordinarily used, is a potash or lime uranium vanadate. Several vanadium minerals occur with the carnotite, so that in mining for uranium a great deal of vanadium is also obtained. At Newmire, San Miguel county, Colo., one of the vanadium minerals, roscoelite, occurs practically free from uranium and is worked for vanadium alone.

The total mine shipments of uranium and vanadium, as shown by preliminary figures, were equal to 2,140 tons of dry ore, carrying an equivalent of 38 tons of uranium oxide. The vanadium in carnotite ores shipped, together with that which is estimated to have been produced from the Newmire district, was equivalent to 914 tons of vanadium oxide. These quantities are equal to about 32.3 tons of metallic uranium and 412 tons of metallic vanadium.

The Bureau of Mines has determined that carnotite carries about 90 per cent. or even a little more of the theoretical quantity of radium in equilibrium with uranium, which, according to Rutherford ("Radioactive substances and their radiations," p. 16), is equal to about 1 gram in 3,000 kilograms of uranium. Assuming that 90 per cent. of the radium is recoverable, this would give 16.40 grams of hydrous radium bromide, worth, about $120 a milligram of metallic radium, about $1,055,000. The total value of the carnotite ores sold was about $142,000, which represents the uranium value only, as little was paid for the vanadium content and the figures for these receipts are not yet in hand.

The production of the year was the largest ever made, according to the Geological Survey figures, that for 1912 being equivalent to 26 short tons of uranium oxide (22 tons of the metal), and that for 1911 being equivalent to 25 tons of uranium oxide (21.2 tons of the metal)—an increase of nearly 50 per cent. for 1913.

Of the quantity produced, apparently 19.25 tons of uranium oxide, containing the equivalent of 8.3 grams of hydrous radium bromide, was shipped to Europe, and 18.75 tons, containing the equivalent of 8.1 grams of hydrous radium bromide, was retained in this country, although in tonnage the quantity retained in this country, 1,198 tons, was larger than that shipped to Europe, which was apparently 942 tons. One of the principal producers for foreign trade did little work for more than half a year, owing, it is reported, to the fact that its factory in Liverpool had not been completed. Had the factory come into operation sooner the exports would have been considerably larger.

A prominent feature of uranium and vanadium production during the year was the change in method of payment by American buyers, who no longer paid for the vanadium content in the ore but bought it on the basis of the uranium oxide content alone, though they received payment for the vanadium abroad. However, the miner received more or less compensation in a higher price for the uranium oxide he sold. Prices varied greatly and returns to the Survey show that the price per pound for contained uranium oxide ranged from $1 for ores carrying 0.6 per cent. uranium oxide to $4.60 for one lot carrying 3.15 per cent. uranium oxide and 4.82 per cent. vanadium oxide.

The demand for carnotite at increasing prices caused a large amount of prospecting, and the carnotite-bearing area was shown to extend from the Paradox country westward into the Dry Valley region of Utah, lying between Monticello and the La Sal Mountains. Farther west and south deposits of carnotite were found on Crescent and Trachyte creeks, in the Henry Mountains, and also southwest of the mountains.

During the fall a geologic reconnaissance of the uranium and vanadium deposits of Utah was made by Frank L. Hess and B. S. Butler, of the United States Geological Survey. They covered the territory lying between the Wyoming line and the south side of the Henry Mountains, and east of the San Rafael Swell. The deposits, as shown by the outcrops, are nearly all in small pockets, part of which are comparatively rich. All the newly found localities are far from railroad and the hope for commercial production from them lies in concentration on the ground by some cheap process, and many experiments are being carried on to develop such a process. Toward the end of the year steps were taken for the erection of a concentration plant in Dry Valley, 15 miles north of Monticello. A plant was put up on Mesa Creek, Colo., and another was said to be in course of erection in the Gateway district. A preliminary report on the uranium and vanadium deposits of Utah will probably be issued during the spring.

The Standard Chemical Company actively produced radium at its plant at Canonsburg, Pa., and the Radium Company of America established a plant and did preliminary work at Sellersville, Pa.

THE PREMEDICAL CONFERENCE

THE Cincinnati Conference of Academic Institutions and Medical Colleges on Premedical Education was held at the University of Cincinnati, January 16–17. The occasion marked the installation of Dr. Christian R. Holmes as dean of the Medical College. The inauguration address was given by Dr. Wm. H. Welch, of Baltimore, his subject being "The Development of Medical Education in America." Dr. Welch was later entertained at a banquet.

Representatives of many of the medical and academic institutions of the Middle West conferred on the requirements of premedical education with a view to bettering and standardizing the preparatory work. Among those who addressed the conference were Pres. Charles W. Dabney, Drs. Wm. H. Welch, Charles Dean Bevan, John A. Witherspoon, N. P. Colwell, Henry B. Ward, Michael F. Guyer, Lauder W. Jones, Brown Ayres, Edgar Brandon, Dean Christian R. Holmes, Paul G. Woolley, Harry Marshall and others. There were present the secretary, two ex-presidents and the president of the American Medical Association.

A committee consisting of Professors Michael F. Guyer (chairman), Harry N. Holmes, Lauder W. Jones, Henry McE. Knower and E. L. Rice drew up the following resolutions, which the conference adopted:

In view of the ideas expressed in this conference, be it

Resolved, That the representatives of the various colleges confer with their respective faculties to ascertain:

1. What courses of a premedical nature are offered by them in chemistry, physics, biology and languages.

2. What changes, if necessary, can be made to establish uniformity of essentials in premedical training.

3. Whether it is possible to reduce the total time now required to obtain the M.D. degree by eliminating duplication of work existing in graded schools, high schools, colleges and medical schools. Your committee is of the opinion that this is feasible.

4. What arrangements are made for granting the bachelor's degree after satisfactory completion of two or three years' college work and one or two years in a Class A plus medical school.

Be it further resolved, That the action taken by the various faculties be reported to Paul G. Woolley, University of Cincinnati, chairman of the general conference committee, and that this committee may, at its discretion, call another general conference of the colleges interested in this movement.

It was generally agreed that physics, biology, chemistry and modern languages have an unquestioned place in the premedical education. Reprints containing the discussion and addresses can be obtained on request from the university.

The delegates inspected the medical college laboratories and the new $4,000,000 city hospital, which Dr. Holmes is just bringing to completion. The plans for the new medical college building, on the hospital site, were exhibited.

THE AMERICAN CHEMICAL SOCIETY

THE forty-ninth meeting of the American Chemical Society will be held in Cincinnati, Ohio, from Tuesday, April 7 to Friday, April 10, inclusive. A meeting of the council will be held at the Hotel Sinton on Monday evening, April 6. The Hotel Sinton has been chosen as headquarters.

The general meetings and the meetings of divisions will be held at the University of Cincinnati.

The transportation committee has arranged a number of interesting visits to local industrial plants. It is a well-known fact that Cincinnati has a very large variety of industries which are strictly chemical or very closely allied. This committee has already arranged trips to the Filtration Plant, Proctor & Gamble's, the home of Crisco and Ivory Soap; Globe Soap Co., Diamalt Co., Andrew Steel Works, Boldt Glass Co., the New Cincinnati Hospital, the largest and most modern city hospital in the world; Machine Tool Plants, Rookwood Pottery, Lloyd Brothers, W. S. Merril Chemical Co., and many others.

In addition to these inspection trips the committee is planning to devote Friday, April 10, to visit adjacent industrial plants—an all day excursion. It is the plan during the morning

to go to Middletown and inspect the plant of the American Rolling Mills, the home of Ingot Iron. After visiting this plant the party goes to Dayton, where members of the Cincinnati Section, residents of Dayton, have arranged an inspection trip through the plant of the National Cash Register Co. Negotiations are now in progress to have Mr. Wright give an exhibition of his latest aeroplane, including the stabilizer.

The following provisional program will give an idea of the plans for the Cincinnati Meeting:

Monday, April 6, evening, council meeting.

Tuesday, April 7, morning, general meeting; afternoon, excursions; evening, smoker at zoo.

Wednesday, April 8, morning, division meetings; afternoon, excursions; evening, concert by the Cincinnati Symphony Orchestra at Emery Hall.

Thursday, April 9, morning, division meetings; afternoon, division meetings; evening, subscription dinner.

Friday, April 10, excursion to American Rolling Mills, Middletown, O., and the National Cash Register Company, Dayton, O.

Following are the addresses of the Divisional and Sectional Secretaries:

Divisions:

Agricultural and Food Chemistry: G. F. Mason, H. J. Heinz Company, Pittsburgh, Pa.

Biological Chemistry: I. K. Phelps, Bureau of Chemistry, Washington, D. C.

Fertilizer Chemistry: B. F. Carpenter, Virginia Carolina Chemical Co., Richmond, Va.

Industrial Chemists and Chemical Engineers: S. H. Salisbury, Jr., Lehigh University, South Bethlehem, Pa.

Organic Chemistry: C. G. Derick, Morris Ave., Lincoln Place, Urbana, Ill.

Pharmaceutical Chemistry: A. P. Sy, University of Buffalo, 24 High St., Buffalo, N. Y.

Physical and Inorganic Chemistry: R. C. Wells, U. S. Geological Survey, Washington, D. C.

Sections:

India Rubber Chemistry: Dorris Whipple, the Safety Insulated Wire and Cable Co., Bayonne, N. J.

Water, Sewage and Sanitation: Harry P. Corson, State Water Survey, Urbana, Illinois.

All Divisions of the Society will meet. The Water, Sewage and Sanitation Section has announced that it is planning a special conference on Standard Methods of Water Analysis. The Rubber Section hopes to have a large meeting, as Cincinnati is conveniently located to some of our largest rubber manufacturing centers.

SCIENTIFIC NOTES AND NEWS

The following fifteen candidates have been selected by the council of the Royal Society to be recommended for election into the society: Dr. Edgar Johnston Allen, Mr. Richard Assheton, Mr. Geoffrey Thomas Bennett, Professor Rowland Harry Biffen, Dr. Arthur Edwin Boycott, Mr. Clive Cuthbertson, Dr. Henry Hallett Dale, Mr. Arthur Stanley Eddington, Professor Edmund Johnston Garwood, Mr. Thomas Henry Havelock, Dr. Thomas Martin Lowry, Professor Diarmid Noël Paton, Mr. Siegfried Ruhemann, Dr. Samuel Walter Johnson Smith and Dr. Thomas Edward Stanton.

The seventieth birthday of Professor A. Engler, the distinguished Berlin botanist, will be celebrated on March 27, when a marble bust will be presented to him.

Professor R. W. Wood, of the Johns Hopkins University, gave in London, on February 27, the first Guthrie lecture of the Physical Society, his subject being "Radiation of Gas Molecules Excited by Light."

Dr. George E. De Schweinitz, professor of ophthalmology in the University of Pennsylvania, was given by the university the degree of doctor of laws, at its recent university-day celebration.

Dr. E. W. Hobson, Sadlerian professor of pure mathematics at the University of Cambridge, has been nominated to represent the university on the occasion of the celebration on June 29–30 and July 1 of the three hundredth anniversary of the foundation of the University of Groningen.

Dr. A. Smith Woodward has been elected president of the Geological Society of London.

Officers of the Royal Astronomical Society have been elected as follows: *President,* Major E. H. Hills; *Vice-presidents,* Dr. F. W. Dyson,

Dr. J. W. L. Glaisher, Professor H. F. Newall and Professor H. H. Turner; *Treasurer,* Mr. E. B. Knobel; *Secretaries,* Professor A. S. Eddington and Professor A. Fowler; *Foreign Secretary,* Professor Arthur Schuster.

AT the recent annual meeting of the State Microscopical Society of Illinois the constitution and by-laws were revised and the following officers elected for the ensuing year:

President—David L. Zook.
First Vice-president—Walter F. Herzberg.
Second Vice-president—Francis T. Harmon.
Treasurer—Frank I. Packard.
Corresponding Secretary—N. S. Amstutz.
Secretary—V. A. Latham.
Curator—Henry F. Fuller.
Trustees—M. D. Ewell, B. U. Hills, Albert McCalla, S. S. Graves and W. G. King.

An annual conversazione meeting will be held on March 12 at the rooms of the Chicago Press Club. The annual soirée in connection with the Chicago Academy of Sciences, Lincoln Park, will be held some time in April.

"MEN of the Old Stone Age in Europe: their Environment, Life and Art" was the subject of the annual Hitchcock Lectures, just given at the University of California as the series for 1914. This year's Hitchcock Lecturer was Dr. Henry Fairfield Osborn, research professor of zoology in Columbia University, and president of the American Museum of Natural History. The latest fruits of excavation and comparative study in various parts of the world were gathered together by Professor Osborn in these lectures. He told of *Pithecanthropus,* the earliest human type as yet discovered; of the recent important English discovery of the Piltdown man; of the Heidelberg man; of the Neanderthal human type; of the Crô-Magnon race, and of the local Grimaldi race. He described the mural art of such caverns as those of Font de Gaume, in France, and Pasiega, Castillo and Altamira, in Spain. After telling of the appearance of the Grenelle race and the Azilian-Tardenoisian culture, he completed his lectures with an account of the beginning of the Neolithic Period, its culture and the sources of its main races.

DR. W. M. DAVIS, Sturgis-Hooper professor emeritus at Harvard University, has gone from Cambridge on a trip to several of the island groups in the Pacific Ocean, where he will study coral reefs. On the outward voyage he will visit the Fiji and other islands, in August he will attend the colonial meeting of the British Association to be held in Australia, and in September will take part in a supplementary meeting promoted by the government of New Zealand. On the return voyage, he will stop at the Society Islands. The trip is made possible by a grant from the Shaler Memorial Fund. Professor Davis lectured before the Colorado Scientific Society at the State School of Mines, Golden, Colo., on "The Front Range of the Rocky Mountains," February 3; at the State University, Boulder, Colo., on "Theories of Coral Reefs," February 4; at Brigham Young University, Provo, Utah, on "The Lessons of the Colorado Canyon," February 6, and before the Leconte Club at the University of California, Berkeley, Cal., on "The Topographic Features of Desert Regions," February 10.

THE Cutter lectures on preventive medicine and hygiene are to be given at the Harvard Medical School this year by Charles V. Chapin, M.D., superintendent of health, Providence, and Dr. Cressy L. Wilbur, chief statistician, Bureau of the Census. Dr. Chapin will give six lectures on municipal sanitation, as follows:

March 20, "Science and Sanitation."
March 27, "Efficiency of Public Health Measures."
April 2, "Organization of the Health Department."
April 9, "Research and Publicity."
April 16, "Nuisance Problems."
April 30, "Contagious Disease Problems."

Dr. Wilbur's subject will be "Vital Statistics in Massachusetts and the United States," and the dates are March 25 and 26.

DR. JOHN M. CLARKE, state geologist of New York, lectured before the Society of Sigma Xi of the Ohio State University on December 27, his subject being "Land Bridges Across the Atlantic."

Professor Arthur H. Blanchard, of Columbia University, on February 24, delivered illustrated lectures at the University of Tennessee on the subjects: "Bituminous Macadam and Bituminous Concrete Pavements" and "Highway Engineering in Europe" and an illustrated lecture on "City Pavements," before the chamber of commerce of the city of Knoxville.

Professor J. Ansel Brooks, of Brown University, on March 2, delivered an illustrated lecture on "The Principles of Efficiency Engineering applied to Highway Engineering," before the graduate students in highway engineering at Columbia University.

On February 28 Sir J. J. Thomson began a course of six lectures at the Royal Institution on recent discoveries in physical science.

Portraits of Dr. John Herr Musser, late professor of medicine in the University of Pennsylvania, and of Dr. Rush Shippen Huidekoper, first dean of the school of veterinary medicine, were presented to the University of Pennsylvania at its university-day celebration on February 23.

Mr. and Mrs. Paul J. Sachs have established a fund for the American Museum of Natural History to be known officially as the Angelo Heilprin Exploring Fund. The money is given in memory of Angelo Heilprin and is to be applied each year to any exploring purpose the museum authorities deem fitting.

Memorial services for Alfred G. Compton, late professor of physics at the College of the City of New York, were held on March 9 in the great hall of the college. Professor Compton entered the college at its foundation and was graduated with the class of 1853. Since his graduation until his retirement in 1911 he was a member of the faculty. Among those who made addresses were: Professor Michael I. Pupin, of Columbia University; Professor Adolph Werner, of the college, and Dr. John H. Finley, state commissioner of education and formerly president of the college.

Professor Edwin J. Houston, formerly of the Central High School of Philadelphia and the Franklin Institute, well known for his work in electrical engineering and for his writings on this and other departments of physics, died on March 1, aged seventy years.

Colonel Alexander Ross Clarke, the distinguished British geodesist, died on February 11, at the age of eighty-five years.

Dr. Julia Cock, consulting surgeon to the New Hospital for Women and dean of the London School of Medicine for Women, died on February 7, aged fifty-four years.

The U. S. Civil Service Commission announces an examination for junior pharmacologist, on April 8, to fill vacancies in this position in the bureau of chemistry, Department of Agriculture, Washington, D. C., at salaries ranging from $1,200 to $1,500 a year.

John Dewrance has presented £2,000 to the donation fund of the Royal Society. The income arising from this fund is applied in promoting experimental researches.

The Bermuda Biological Station for Research will be opened in June for a period of about six weeks. Members have facilities for shore collecting, dredging and marine towing down to a depth of 100 fathoms. Inquiries should be sent to Dr. E. L. Mark, 109 Irving St., Cambridge, Mass.

According to the resolutions of the meeting of October 25, 1912, at Lyons, the secretary's office of the permanent committee for the International Veterinary Congresses has been definitely established at The Hague from January 1, 1914, under the patronage of the Dutch Department of Agriculture, Industry and Commerce. The address of the office is as follows: "Secretary's Office for the Permanent Committee for the International Veterinary Congresses at The Hague, Stationsweg 74 (Int. Tel. 848)." Correspondence, publications, etc., as far as they are not sent to the president of the committee, Dr. A. Lydtin, at Baden-Baden, or to the secretary, Professor Dr. D. A. de Jong, at Leyden, are to be addressed to this office.

With the cooperation of fifty different organizations devoted to social progress and civic welfare, Reed College will hold a conference on May 15, 16 and 17, as a clearing house for

welfare workers and a stimulation for the activities of the city for the year 1915. This Portland 1915 conference will be similar in scope and method to the Reed College conference on the conservation of human life held last May.

A NEW edition of "Les observatoires astronomiques at les astronomes," first published in 1907, is in course of preparation, under the direction of members of the Royal Observatory of Belgium, with Professor P. Stroobant as chairman. He will be glad to receive information from directors of observatories and private astronomers concerning their work and publications.

UNIVERSITY AND EDUCATIONAL NEWS

THE College of Agriculture and the Mechanic Arts of North Carolina is preparing to celebrate on the first three days of October the twenty-fifth anniversary of the first opening of the college. A tentative program has been adopted at a meeting held in the office of Governor Locke Craig, who is *ex officio* chairman of the board of trustees and at the head of the advisory committee which is cooperating with the committee of arrangements. In order to make the quarter-centennial celebration a complete success, efforts will be made to have in connection with it reunions of the twenty-two classes which have so far been graduated. There will also be social meetings, addresses by some of the distinguished men who took part in the founding of the college, and other interesting features. The celebration proper will take place on the morning of October 3, with the principal addresses, but the other meetings will not be at all lacking in interest. Guests who will be held in special honor throughout the celebration will be those who took part in the movement which resulted in the founding of the college.

THE faculty and students of the University of Pittsburgh held a banquet on February 25.

AT the end of the current college year, Dr. Albert Benedict Wolfe, head of the department of economics and sociology, will withdraw from the Oberlin faculty in order to accept the headship of the department of sociology and economics in the University of Texas.

PROFESSOR O. PERRON, of Tübingen, has accepted the professorship of mathematics at Heidelberg, as successor to Professor L. Koenigsberger.

DISCUSSION AND CORRESPONDENCE

STANDARD UNITS IN AEROLOGY

IN SCIENCE, January 2, 1914, p. 31, it is stated that Blue Hill Observatory would use the new units for atmospheric pressure and temperature, *i. e.*, the units proposed by Köppen at Monaco in 1909 and again by V. Bjerknes at the Vienna meeting of the International Commission for Scientific Aeronautics, 1912. In this system, pressure is expressed in bars or decimal parts thereof, such as decibar, centibar and millibar. One million C.G.S. units constitutes a bar.

Professor A. E. Kennelly, visiting this observatory, called attention to the inconsistency of such use of the term "bar." Unknown to meteorologists at home or abroad, apparently, the bar has been defined and used with a different value. Professor T. W. Richards in 1903,[1] suggested that the pressure of a dyne per square centimeter be called a bar;[2] and while investigation shows that somewhat similar suggestions had been made by others, Richards's was independently made, original and legitimately deduced. Kennelly[3] and others following Richards have used the bar in this sense. It has therefore priority of definition and usage and is moreover the logical and appropriate unit of pressure. For the unit proposed by the aerologists, a more fitting designation would have been "aer" or "atmos."

Unless some protest be made against the proposed bar of the aerologists, we add to the confusion of units and terms already existing in meteorology. It is important too that we

[1] Publication 7, Carnegie Inst., 1903, p. 43.

[2] "New Method of Determining Compressibility," T. W. Richards and W. N. Stull, *Jour. Am. Chem. Soc.*, Vol. XXVI., April, 1904.

[3] "Convection of Heat from Small Copper Wires," A. E. Kennelly, C. A. Wright and J. S. Van Bylevelt, *Trans. Am. Inst. Elec. Engineers*, June, 1909.

make the correction *now* at a time when we are trying to break away from the old order, attempting to introduce rational units in place of the old arbitrary ones. It is somewhat embarrassing for one who has advocated the introduction of absolute units to acknowledge the validity of the criticism of chemist, physicist and engineer; but fortunately the corrections can be made readily by changing the millibar of the aerologist to kilobar. In the conversion tables which are in course of preparation, this will be done.

Briefly, the term "barad" was proposed by a committee of the British Association for the Advancement of Science, 1888, as a suitable term for the unit of pressure, one dyne per square centimeter. Some years later Ostwald advocated the use of one million of these units as the standard, but gave the standard no name. The term *bar* was proposed by Richards in 1903 for the small unit of pressure, one dyne per square centimeter; and *megabar* for a C.G.S. atmosphere. So far as I can ascertain this is the first case in which a clear-cut definition of an absolute atmosphere has been used in actual investigation. He has consistently used this unit megabar as the basis of his work ever since. Richards's atmosphere is 0.987 of the ordinary sea-level atmosphere or 1.020 kilograms per square centimeter; and under the new order agrees with the standard level of Köppen, the million-dyne level at about 106 meters elevation.

It seems almost unnecessary to argue that the smaller bar should be the basic unit and not some multiple. And again it is doubtful if bar is the best designation for the pressure of an absolute atmosphere. Megabar is not altogether inappropriate and has priority of usage especially in the literature of chemistry. A megabar in the aerologist's notation would be the pressure of a million atmospheres, a magnitude not often dealt with. On the other hand, we often need to refer to pressures smaller than the millibar of the aerologist. The bar of the chemist and physicist is conveniently divisible down to its millibar, *i. e.*, a thousandth of a dyne per square centimeter.

The following table contrasts the two systems. At Dr. Richards's suggestion it is restricted to those terms most likely to be used.

Chemist's and Physicist's (to be Universally Used Hereafter)	Former Aerologist's (to be Abandoned)	Remarks
.....	1 megabar	One million atmospheres, far beyond our present possibilities of direct measurement.
1 megabar	1 bar	The absolute atmosphere; equal to 750.1 mm. mercury or .987 usual sea-level atmosphere. One megadyne per square centimeter acting through one cubic centimeter does one megerg of work.
1 kilobar	1 millibar	One kilodyne per square centimeter.
1 bar	.....?	One dyne per square centimeter acting through one cubic centimeter does one erg of work.

There would be no objection to giving the term megabar or absolute atmosphere some convenient nickname such as "aer" if megabar is too ponderous. It has been suggested by Professor Richards that for historical reasons the pressure of 10,000,000 dynes (ten absolute atmospheres) might be named after some pioneer in meteorology, as Guericke or Torricelli, after the analogy of the "watt," "joule," "ampere," etc., but this need not be insisted on at present.

Alexander McAdie

Blue Hill Observatory,
February 28, 1914

ACADEMIC ELECTIONS

To the Editor of Science: In connection with the table of percentages accompanying my article on "Academic Student Elections," in Science for January 16, a correspondent has called my attention to some inaccuracies in copying percentages from Professor Ferry's tables, on which the article was based. With one exception they do not seem very important. This exception is in connection with the work in biology at Bowdoin College. The entry was from the wrong column of Professor Ferry's extended table, and to Bowdoin was assigned the lowest record in this subject. A

considerably lower record, more than a third lower, belonged to another institution.

It seems only fair to Bowdoin College, and especially to its professor of biology, to publish this correction of an unfortunate oversight.

W. LECONTE STEVENS
LEXINGTON, VA.,
January 31, 1914

SCIENTIFIC BOOKS

Chippewa Music. II. By FRANCES DENSMORE. Smithsonian Institution. Bureau of American Ethnology. Bulletin 53. 1913. Pp. 314. 51 illustrations. 180 songs. 14 tables giving "melodic analysis of 340 songs." 7 tables of "rhythmic analysis" and a table giving "comparison of metric unit of voice and drum."

Bulletin 53 together with bulletin 47 (1910) are devoted to Miss Densmore's study of Chippewa music begun in 1907 and brought to a close in the present volume. In this bulletin the author presents the results of six years of labor, gathering songs from the Chippewa in their native environment and making careful studies of the songs themselves. By these means she has sought to answer three questions: What do the Chippewas sing? How do they sing? Why do they sing? The answers to the first two are presented in a clear, painstaking manner and in such form as to make them conveniently serviceable for comparative study. The third question is concerned with the psychological aspects of Indian song and consequently its answer could not easily be formulated in the same manner as those relating to the other two questions, nevertheless the author has recorded her observations on this point among the Chippewa. Truthfulness and earnestness of purpose characterize this book as well as an appreciation of the people from whom the material was secured. The work has a special value to the student of musical development and presents points of interest to the ethnologist. The Bureau of American Ethnology is to be congratulated upon its entrance into an important field and particularly upon its selection of so able and scholarly an investigator as Miss Densmore to conduct this difficult line of research.

An ample index adds to the usefulness and pleasure of the book. ALICE C. FLETCHER

Fosseis Devonianos Do Paraná. Pelo DR. JOHN M. CLARKE. Monographias do Servico Geologico E Mineralogico do Brasil. Vol. I., Rio de Janeiro. 1913. Pp. xx + 353; pl. I.–XXVII.

A monograph upon the Devonian of the state of Paraná, Brazil, which has been published recently by the Geological Survey of that country, constitutes a notable contribution to our knowledge of the geology of South America. The author of the work is Dr. John M. Clarke, the accomplished state geologist of New York. Long an investigator of the Devonian of that state, he has recently issued a number of monographs upon strata of the same age in both North and South America, including works upon the Lower Devonian of the Gaspé region, Canada, and upon the Devonian of the State of Pará, Brazil. To these he has now added this important monograph upon the Devonian of Paraná.

The volume consists of two parts. The first part comprises a discussion of the character and significance of the Devonian faunas of the region studied, while the second is devoted to a description of the species, with critical comments upon their relations to those of other areas.

The Devonian of America presents two broadly conceived types: a northern or boreal, confined chiefly to North America and the region north of the Amazon, and a southern or austral type. Dr. Clarke shows that the Devonian sediments found in South America, from central Brazil southward, contain an austral fauna. The latter, which differs from the boreal fauna in many respects, is a unit throughout its range, having definite and recognizable characteristics wherever found.

While the work before us is entitled a discussion of the Devonian Fossils of Paraná it is in reality a monograph upon the austral Devonian of the whole of South America. The author gives a critical discussion of the

strata and fauna of this facies not only in Paraná, but also in the state of Matto Grosso, Brazil, Bolivia, Argentina and the Falkland Islands. The work hence possesses a wide scope.

The stratigraphic succession in Paraná is as follows, in descending order: Tibagy sandstone, Ponta Grossa shales, Furnas sandstone. The strata are underlain by an ancient, crystalline complex, and are overlain by Permo-Carboniferous deposits containing glacial till. A very interesting member of this series is the barren, basal Furnas sandstone, which appears to be paralleled by a similar sandstone situated at the base of the Devonian in Bolivia and Argentina. It overlies, at different places, ancient crystallines, Cambrian and Silurian strata, and hence seems to indicate a widespread transgression of the sea in South America at the beginning of Devonian time.

The austral fauna is believed by Dr. Clarke to be of Lower Devonian age, and is considered by him to have sprung from a boreal Silurian ancestry, owing its peculiarities to its development in isolation in southern waters.

One of the most notable aspects of the discussion is the fact, brought out with great clearness, that the American austral Devonian fauna finds its nearest relative in the Bokkeveld fauna of the same age in South Africa. Indeed the species of the Falkland Islands are more closely akin to those of South Africa than they are to those of the state of Paraná.

These relations lead to an interesting reconstruction of the lands and continents of Devonian time. The existence of a more or less intimate connection between Africa and South America had been foreshadowed with greater or less clearness by various writers. The author suggests that an Antarctic continent existed at that time, whose strand stretched from South Africa to the Falkland Islands and thence north into Chile and Argentina, along which the austral species migrated. A large island situated near the present state of Paraná was separated from the Antarctic continent by a comparatively narrow waterway.

A northern land mass embraced the northern part of South America and a large area on the site of the present North American continent. A land bridge is believed to have extended across the north Atlantic ocean, uniting North America and Europe, its existence being indicated by the close relation of the early Devonian faunas of Maine to those of the Coblentz district on the Rhine. It is thought probable that the center of dispersion of the austral species was located in central Africa. The division of the Lower Devonian faunas into a boreal and austral facies and their geographic distribution are explained by these facts.

The larger part of the monograph is devoted to a description and critical discussion of the species constituting the austral Devonian fauna of South America and a consideration of their relations to those of South Africa.

Illuminating comments are made upon the distinguishing characteristics of the austral types in connection with the discussion of the leading groups, the treatment of the characteristics of the trilobites being especially valuable.

The work is published in the English and Spanish languages in parallel columns. Its illustrations are of a high order of excellence. The monograph is a notable contribution to our knowledge of the geology of South America and is a credit both to the author and to the Geological Survey of Brazil.

Charles K. Swartz

Baltimore, Md.

SPECIAL ARTICLES

A NEW CYTOLOGICAL STAINING METHOD

During the course of an investigation on spireme formation and chromosome number in the pollen-mother cells of various species of *Lilium* and *Nicotiana,* considerable time was expended in testing and experimenting with stains and staining processes. In plants such as *Nicotiana,* where the chromosomes are small and the characteristic number is large (48) (24), it is desirable, especially in certain phases of the maturation phenomena, to have a stain combination which will differentiate

chromosomes sharply from the other cell material and at the same time produce a chromosome stain translucent enough so that each chromosome in a crowded equatorial plate will stand out by itself. In the synapsis condition of the spireme, a translucent but extremely "contrasty" differentiation between the tightly massed thread and other cell materials was also thought desirable. Flemming's safranin, gentian violet, orange G combination and iron hematoxylin were usually unsatisfactory in attempting to secure the sought-for results.

Magdala-red was tested out after the methods given by Chamberlain,[1] but with unsatisfactory results. Both strong and weak solutions of the stain were used, but for chromatin and chromosome staining it never appeared to possess "body" enough to give a sharp contrast when used with anilin-blue or other blue cytoplasmic stains. After a preparation had been in the stain bath for 24 hours, the red color easily washed out during the hurried passage through acid alcohol, 95 per cent. neutral alcohol, etc., to xylol. Occasionally fair preparations were obtained, but when these were examined by artificial light, the red stain, through lack of "body," lost its brilliancy and contrast value.

The thought occurred to try mixing magdala-red with safranin O, and thus remedy the "lack of body" defect of the former and increase the brilliancy and translucency of the latter. Accordingly, a solution of safranin, made up of equal parts saturated solution of safranin O in 50 per cent. alcohol and a saturated solution of safranin in a 3-per-cent. solution of anilin oil in water, was mixed with a strong (saturated) solution of magdala red in 9 per cent. alcohol. The precipitate thrown down upon mixing the two stains was eliminated by filtering and the red solution remaining was used as the stain. Serial section preparations on the slide were allowed to remain in this stain for varying lengths of time—24 hours in most cases, after which they were treated with anilin-blue, etc., after the method as given by Chamberlain, p. 48. Many variations in method were practised; the main thing being to allow the red stain to act for a long time and the blue a very short time. The necessity of using the hydrochloric acid to bring out the brilliancy of the anilin-blue and to produce the desired contrast effect made the process undependable where good preparations were constantly desired. In other words, where only a small amount of material was to be had and every slide preparation must be made to count, as in much research work, the method was not a practicable one.

In order to eliminate the use of acid, the anilin-blue was discarded, and a saturated solution of azure II was substituted. This combination of magdala-red-safranin and azure II gave in most cases good results. A brilliant red and blue were both obtainable without the use of acid. From the solution of magdala-red-safranin, the slide was dipped directly into the azure II, allowed to remain about a second, and then rushed through the higher alcohols to xylol and neutral balsam. Variations in practise were common and it has been my intention here merely to indicate the general method. In many cases, satisfactory results were obtained by shortening the bath in the red stain to an hour or even to 30 minutes.

Preparations of reduction division stages in the pollen-mother-cells of *Lilium canadense* L. were stained as follows: cytoplasm, deep brilliant royal blue or greenish blue; spindle fibers dark blue and sharply outlined against the cytoplasm; nucleoli, usually blue in active and red in "resting" nuclei, chromatin substance (spireme, etc.) brilliant deep ruby red. Preparations of pollen-mother-cells of *Nicotiana* in early prophase have been obtained in which the vacuolated nucleoli were stained blue and little beadlike globules within the nucleolar vacuoles shown brilliant red. The chromatin is aways stained a brilliant red and against the background of dark blue cytoplasm the contrast is extremely sharp. Chromosomes in those plants where their numbers are large are ordinarily counted with extreme difficulty, even under the most favorable conditions, owing to the crowding of the chromosomes on

[1] "Methods in Plant Histology," 2d ed., 1905, pp. 42, 44, 47–48, 79–83.

the spindle. The process just described will, I believe, partially eliminate this difficulty, as the red is somewhat translucent and each chromosome seems to stand out by itself, even when one lies above the other. Mature pollen of *Lilium tigrinum* Ker. when fixed in Flemming and embedded and sectioned in the usual manner reacts to the process as follows: outer wall, sculpturing, etc. (perine), bright red; extine, intine and cytoplasmic structures blue or bluish green; chromatin granules and nucleoli in "resting" nuclei, red; other nuclear material blue; nuclei as a whole well differentiated from surrounding cytoplasm.

Orland E. White

Brooklyn Botanic Garden,
January 31, 1914

THE AMERICAN MATHEMATICAL SOCIETY

The society held two large meetings during the Christmas holidays, one at the University of Chicago on December 26–27, the other at Columbia University on December 30–31. The New York meeting was the annual meeting of the society, and was especially marked as the occasion of the presidential address of Professor H. B. Fine, on "An Unpublished Theorem of Kronecker Respecting Numerical Equations."

Eighty members attended the four sessions. Professors W. F. Osgood and H. B. Fine occupied the chair in succession. The following new members were elected: Professor Pierre Boutroux, Princeton University; Mr. E. H. Clarke, Purdue University; Dr. W. H. Cramblet, University of Rochester; Mr. H. J. Ettlinger, University of Texas; Professor W. S. Franklin, Lehigh University; Mr. H. Galajikian, Princeton University; Professor W. W. Hart, University of Wisconsin; Mr. Barnem Libby, University of Michigan; Mr. G. W. Mullins, Columbia University; Mr. J. A. Northcott, Columbia University; Dr. Mildred L. Sanderson, University of Wisconsin; Mr. J. M. Stetson, Princeton University. Nine applications for membership were received. The total membership of the society is now 710, including 66 life members.

The Treasurer's report shows a balance of $9,153.58. Sales of publications during the year have amounted to $2,111.45. The library has increased to 4,902 volumes. The number of papers read at all meetings was 240.

At the annual election the following officers and members of the council were chosen:

Vice-presidents: L. P. Eisenhart and E. J. Wilczynski.

Secretary: F. N. Cole.

Treasurer: J. H. Tanner.

Librarian: D. E. Smith.

Committee of Publication: F. N. Cole, Virgil Snyder, J. W. Young.

Members of the Council to serve until December, 1916: C. N. Haskins, L. M. Hoskins, E. V. Huntington, H. L. Rietz.

The annual dinner, on Tuesday evening, was attended by forty-seven members.

The Madison Colloquium Lectures, delivered last September by Professors L. E. Dickson and W. F. Osgood, are now in press and will soon be published by the society.

The following papers were read at the annual meeting:

L. L. Dines: "Complete existential theory of Sheffer's postulates for Boolean algebras."

Arnold Emch: "Two convergency proofs."

J. L. Coolidge: "Congruences and complexes of circles."

Dunham Jackson: "On the degree of convergence of Sturm-Liouville series."

Virgil Snyder: "Birational transformations of the cubic variety in four-dimensional space."

Miss A. H. Tappan: "Plane sextic curves invariant under a group of linear transformations" (preliminary communication).

C. L. Bouton: "Explicit formulas for the inverse of an analytic transformation in n variables."

Edward Kasner: "The classification of conformal transformations."

L. B. Robinson: "Questions of logic arising from the study of systems of partial differential equations" (preliminary report).

Pierre Boutroux: "On a family of rational differential equations of the first order."

H. B. Fine, presidential address: "An unpublished theorem of Kronecker respecting numerical equations."

W. A. Hurwitz: "Note on the Fredholm determinant."

G. D. Birkhoff: "The restricted problem of three bodies."

E. V. Huntington: "On the accuracy of the contracted form of Horner's method."

O. E. Glenn: "On an analogy between formal modular invariants and the class of algebraical invariants called Booleans."

G. C. Evans: "Green's functions for linear partial differential equations of the second order, and Green's theorem."

W. R. Longley: "An existence theorem for a certain differential equation of the nth order."

W. C. Graustein: "The real congruence of complex points, planes, lines."

H. W. Reddick: "Conformal invariants of orthogonal curve nets" (preliminary communication).

W. F. Osgood: "Liouville's theorem concerning periodic functions of several variables."
L. M. Kells: "A complete characterization of dynamical trajectories in n-space."
W. H. Cramblet: "A classification of discontinuous functions and some allied problems."
J. K. Lamond: "Note on the reduction of multiple L-integrals to iterated L-integrals."
L. A. Howland: "Functions of n variables which are functions of r combinations of these variables."
J. I. Tracey: "Covariant curves of the plane rational quintic."
A. B. Coble: "Restricted systems of equations."
L. P. Eisenhart: "Transformations of surfaces of Voss."
H. Galajikian: "A type of non-linear integral equation."
T. H. Gronwall: "On systems of linear total differential equations."
T. H. Gronwall: "Extension of Laurent's theorem to several variables."
T. H. Gronwall: "On approximation by trigonometric sums."
R. D. Beetle: "Cyclic systems of osculating circles of curves on a surface."
G. M. Green: "Canonical systems in projective differential geometry, with special reference to the theory of curved surfaces."
J. H. M. Wedderburn: "A type of primitive algebra."

F. N. COLE,
Secretary

THE AMERICAN SOCIETY OF NATURALISTS

THE thirty-first annual meeting of the American Society of Naturalists was held in the Zoological Laboratory of the University of Pennsylvania on December 31, 1913. In affiliation with the society this year were the American Society of Zoologists, the American Association of Anatomists and the Federation of American Societies for Experimental Biology.

A revised constitution and by-laws was adopted with several important modifications of the old constitution:

1. The former division of the society into an eastern branch and a central branch was abolished. "Sections of the society may be organized in any locality, with the approval of the society in each case, by ten or more members for the purpose of holding meetings for the presentation of scientific papers. Such sections shall have the right to elect their own officers and associate members, but associate membership in any section shall not confer membership in the society.

2. The executive committee is permitted at its discretion to remit for any year the annual assessment of one dollar.

3. The secretary and treasurer are to be elected for terms of three years each. An additional member of the executive committee is to be elected each year to serve for three years.

4. "A committee of three, consisting of the president, vice-president and secretary, shall arrange a program for each meeting."

5. "The records of the society shall be published once every three years, beginning in 1914."

6. "The society shall reimburse the secretary for traveling and hotel expenses incurred in attending the annual meeting."

The following were elected to membership in the society: Irving W. Bailey, Harvard University; Arthur M. Banta, Carnegie Station for Experimental Evolution; Harley H. Bartlett, Bureau of Plant Industry; Charles T. Brues, Harvard University; Philip P. Calvert, University of Pennsylvania; Mintin A. Chrysler, University of Maine; R. A. Gortner, Carnegie Station for Experimental Evolution; Milton J. Greenman, Wistar Institute; Robert W. Hegner, University of Michigan; Lawrence J. Henderson, Harvard University; Merkel H. Jacobs, University of Pennsylvania; G. L. Kite, Henry Phipps Institute; Ralph S. Lillie, Clark University; Clarence E. McClung, University of Pennsylvania; J. H. McGregor, Columbia University; Edward B. Meigs, Wistar Institute; J. Percy Moore, University of Pennsylvania; Alice Robertson, Wellesley College; Edmund W. Sinnott, Harvard University; Arlow B. Stout, New York Botanical Garden; P. W. Whiting, Harvard University.

The program of the morning session was as follows:

"Some Physiological Phases of the Study of Teratological Variations," by J. Arthur Harris.

"Some Physiological Observations Regarding the Genetic Factors for Plumage Patterns," by Raymond Pearl and Alice M. Boring.

"Twin and Triplet Hybrids from Wild Species of *Œnothera* with Segregation in the First Generation," by George F. Atkinson.

"The Functions of an Environment," by Lawrence J. Henderson (by invitation).

"A New Method of Analysis of Fertilization: Results and Theory," by Frank R. Lillie.

"On the Adaptation of *Fundulus* to Abnormal Salt Solutions," by Jacques Loeb. (Read by title.)

"Sex Recognition and Sexual Selection in Vertebrates," by Jacob E. Reighard.

"Endemic Species from Ancient Strands and Recently Observed Modifications of Seed-plants on the Beaches of the Salton Sea," by Daniel T. MacDougal. (Read by title.)

"Divergent Characters of the Progeny Arising from Seed Maturing in Treated Ovaries of *Scrophularia occidentalis*," by Daniel T. MacDougal. (Read by title.)

"Association of Hereditary Factors in Parthenogenetic Lines of *Hydatina*," by A. Franklin Shull.

"An Inherited Variation in the Strength of Linkage," by A. H. Sturtevant (by invitation).

"Size Inheritance in *Drosophila*," by Edward N. Wentworth. (Read by title.)

"Studies on Inheritance in Orthoptera," by Robert K. Nabours (by invitation).

"Physiological Resistance to Drought in F_2 Segregates of Certain Maize Crosses," by Herbert P. Roberts. (Read by title.)

"Partially Sterile Crosses between Species of *Nicotiana*," by Edward M. East. (Read by title.)

"Reciprocal Crosses between *Œnothera biennis* and *Œnothera muricata*," by Bradley M. Davis. (Read by title.)

The session of the afternoon consisted of a symposium on the subject "The Scope of Biological Teaching in Relation to New Fields of Discovery," Papers were presented by Michael F. Guyer, University of Wisconsin—Zoology; Mintin A. Chrysler, University of Maine—Botany; Robert R. Bensley, University of Chicago—Anatomy and Medicine; George H. Parker, Harvard University—General Physiology.

In the discussion following the reading of the four principal papers, Drs. Goldfarb, Atkinson, Loeb, Clapp, McMurrich, Morgan, McClung, Lefevre, Reighard, Henderson and Knower participated.

The Naturalists' dinner was held on the evening of December 31, at the Hotel Walton, with one hundred and ten in attendance. The president's address by Professor Ross G. Harrison was entitled "Science and Practise."

The officers of the Society for 1914 are:

President—Samuel F. Clarke, Williams College.

Vice-president—Frank R. Lillie, University of Chicago.

Secretary—Bradley M. Davis, University of Pennsylvania.

Treasurer—J. Arthur Harris, Carnegie Station for Experimental Evolution.

Additional Members of the Executive Committee—Raymond Pearl, Maine Agricultural Experiment Station; Ross G. Harrison, Yale University, and Elias P. Lyon, University of Minnesota.

Bradley M. Davis,
Secretary

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

SECTION E—GEOLOGY AND GEOGRAPHY

The sixty-fifth meeting of Section E, Geology and Geography, of the American Association for the Advancement of Science was held in the senate chamber of the state capitol, Atlanta, Ga., December 28, 1913, to January 1, 1914. Vice-president J. S. Diller presided. Professor U. S. Grant, Northwestern University, Evanston, Ill., was elected vice-president of the association and chairman of Section E for the next meeting to be held in Philadelphia. Dr. E. H. Sellards, state geologist of Florida, was elected a member of the council, Dr. David White, United States Geological Survey, a member of the sectional committee, and Dr. S. W. McCallie, state geologist of Georgia, a member of the general committee.

In connection with the meeting the following resolutions were unanimously adopted:

Whereas, it is recognized that the American Association for the Advancement of Science is the great scientific organization of this country, and,

Whereas, it is hoped that this organization may continue to fulfil its great function as the representative of science in America,

Be it Resolved, that it is the sense of Section E, an important branch of the parent organization, that the strongest men interested in geology and geography should be urged to assist in every way possible in promoting the best interests of the general organization,

Furthermore, in the belief that these purposes can be most effectively accomplished by the cooperation of existing geological and geographical organizations, it is recommended that every effort be made to have the meetings of the Geological Society of America and the Association of American Geographers held, as frequently as possible, in connection with those of the American Association for the Advancement of Science,

It is Further Recommended, that the officers of Section E, with the approval of the council, be instructed to take such steps as are necessary to secure the desired results.

The address of the retiring Vice-president, Professor J. E. Todd, was given on the subject, "Pleistocene History of the Missouri River."

The program consisted of more than thirty papers, the majority of which dealt with the mineral resources of the southern states. It is hoped that all the papers on the mineral resources of the southern states may be published in one volume. As an aid to such publication the council voted the sum of $200.

The titles and abstracts of papers presented before Section E are given below:

Mineral Resources of the Southern States—Distribution and Production: J. S. DILLER. (Illustrated by map and collection of specimens.)

In opening the discussion of the mineral resources of the southern states, Mr. Diller called attention to a large wall map recently prepared by the United States Geological Survey to show the distribution of the most important mineral resources of the sixteen states included in the southern section.

Of the various mineral products found in the United States only two, borax and platinum, are not produced in the southern states but, on the other hand, some of the southern states are the largest or exclusive producers of nearly a dozen substances, among which phosphate rock, manganese, bauxite, sulphur, barite and fuller's earth occur.

There are 55 different mineral substances won from the earth in the southern states, and of these a collection consisting of more than a hundred specimens was exhibited at the meetings of Section E.

Coal is the resource of first importance. The value of coal alone produced in 1912 was more than 144 million dollars, with large reserves, as shown on the map, that will last for centuries.

The total production of mineral resources in 1912 was $401,399,483.

Nearly a score of other substances in addition to coal were produced in the same region to the value of more than a million dollars each, and while the distribution of the reserves of these resources was shown on the large map the value of the production of each during 1912 was shown on a chart.

It is expected that the map and chart will be published in connection with the volume of papers read before Section E on the mineral resources of the southern states.

The Coal Resources of the Southern States: L. C. GLENN.

This paper summarized our knowledge of the coal resources of the southern states, indicated the trend of present developments, and showed the importance of the rôle to be played by coal in the future industrial development of the south. It was illustrated by charts and diagrams.

The Petroleum Resources of the Southern States: D. W. OHERN.

The Marbles and Granites of the Southern States: S. W. MCCALLIE.

The geographical and geological distribution, history and extent of development, physical and chemical characteristics, and commercial uses of the marbles and granites of the southern states.

The Mines and Quarries of Georgia: S. W. MCCALLIE. (Illustrated with lantern slides.)

The Piedmont Limestones of the Southeast Atlantic States: THOMAS L. WATSON AND J. S. GRASTY.

This paper discusses the occurrence and distribution, structural and age relations, composition and uses of the Piedmont limestones of the southern Atlantic states, including Maryland to Alabama. It points out their much wider distribution than has been formerly supposed and suggests their Lower Cambrian (Loudoun) age. Besides being of economic importance in many of their occurrences, these limestones form extremely important and valuable guide members in the structural work necessary to determine the stratigraphic and age relations of the associated rocks.

The Limestones of Maryland, East of the Blue Ridge: J. S. GRASTY.

This paper is devoted to the various occurrences of limestone in the Piedmont section of Maryland, and embraces a discussion of their age, stratigraphy, structure and economic importance. With the exception of the occurrences in the Frederick Valley, and in the vicinity of Baltimore, practically no attempt, based on systematic study, has been made heretofore at a correct correlation. It is believed that it can be shown definitely and satisfactorily that the limestones in the middle part of this physiographic division (Piedmont) of Maryland should be assigned to the Potsdam group of the Cambrian, though-be-it this is at variance with the general geological impression, which is that they are older, a view entertained, perhaps, because of their association in areal occurrence with other rocks definitely known to be pre-Cambrian.

The Slate Deposits of the Southern States: J. S. GRASTY AND J. H. CLINE.

This paper is devoted to a discussion of the more important slate deposits of the southern states, including their location, structural and age relations, quality, etc., particular attention being given to those areas occupied by active operations. This accounts, therefore, for the prominent position and greater space being given in this discussion to the occurrences in Virginia and Maryland. Slates occur also in Georgia, notably the green slate found to the north of Cartersville, and in Arkansas, Tennessee, West Virginia and elsewhere in the south.

The Cement Materials and Industry of the Southern States: Thomas L. Watson and J. S. Grasty.

The Portland cement industry in the southern states is an important and growing one. Calcareous (limestones or marls or both) and argillaceous (clays, shales and slates) materials are found in each of the southern states, being particularly well developed in those states traversed by Ordovician, Silurian and Devonian rocks. The present paper discusses the occurrence and distribution of these materials, including composition, and explains how their adaptability for use in the manufacture of Portland cement may be determined.

The Gypsum Resources of the Southern States: Frank A. Wilder.

Gypsum in quantities sufficient to be of commercial importance occurs in Oklahoma, Texas and Virginia. In Arkansas large deposits are said to exist in Pike county but their fitness for plaster can not be positively stated. A small body of gypsum is reported from Bear Island near the post-office of Panassoffke, Fla., but this deposit is of doubtful commercial importance.

The deposits in Oklahoma and Texas are inexhaustible and consist of both rock gypsum and gypsum earths known as gypsite.

The Virginia deposit is much more limited in area and in tons available, but can probably maintain an annual output of 200,000 tons for fifty years or more.

The Virginia gypsum deposit is peculiar on account of the rather unusual relationships between the gypsum and a pronounced fault which has thrust Cambrian dolomite over the gypsum-bearing formations which we regard as of Mississippian age.

On account of the rapid increase in the use of gypsum plasters, gypsum tile for fireproofing, and in portland cement, of which gypsum is a minor but very essential ingredient, these gypsum deposits are important factors in the development of the south.

In connection with agriculture ground gypsum is regarded as essential in the raising of peanuts and is useful in the cultivation of all legumes. It doubtless is the cheapest way to restore sulphur to the soil where this element has been exhausted, and reacts on insoluble potash compounds, rendering them more soluble.

The Gypsum Resources of Texas and Oklahoma: E. T. Dumble.

The location and character of the gypsum deposits of Texas and Oklahoma now being exploited commercially. Present development of the industry, and possibilities of this area. Description of other areas in Texas susceptible of similar development.

The Bauxite Industry in the Southern States: W. C. Phalen.

The production of bauxite in the United States in 1912 was, in round numbers, 160,000 long tons, valued at approximately $775,000. In other words, this means the production of bauxite in the southern states, for the mining of this mineral is strictly a southern industry, and such it has been since its inception in the United States.

The states which produced bauxite in 1912 are as follows: Alabama, Arkansas, Georgia and Tennessee. A deposit of the mineral is known also in Botetourt county, Virginia, but it has never been exploited. Arkansas led in the production, as it has for many years, followed distantly by Georgia, Alabama and Tennessee, named in the order of their production and the value of same.

Bauxite has a variety of uses, which are as follows: (1) As raw material in the production of metallic aluminum, (2) in the manufacture of aluminum salts, (3) in the manufacture of bauxite brick, (4) in the manufacture of alundum (fused alumina) for use as an abrasive, and (5) in the manufacture of calcium aluminate.

The use of bauxite in the manufacture of metallic aluminum is by far the most important of those enumerated above. A large part of the entire output of Arkansas is used in the aluminum industry, and the production from this state has shown phenomenal growth during recent years. When it is considered that more than 65,000,000 pounds of the metal were consumed in the United States during the past calendar year, and that this aluminum in the form of No. 1 ingots, whole-

sale lots in New York City varied in price per pound from 18½ to 27 cents, the importance of the relation of bauxite production to what promises to be one of our most important future metallic industries becomes apparent, as does also the importance of a careful search for future supplies of the mineral.

The Outlook for the Aluminum Industry in the South:

Two water-power installations of great magnitude, for the manufacture of metallic aluminum, are now in process of construction in the southern states. One of these is by the Southern Aluminum Company and the other by the Aluminum Company of America. The former, with a capital of several million dollars, has been organized by an amalgamation of foreign aluminum interests, chiefly French, together with certain metal interests in the United States, and has acquired a water-power site on the Yadkin River, near Whitney, North Carolina. The company is now engaged in the development of the property, and has plans to erect, eventually, a complete plant with large capacity for the manufacture of the metal.

In addition, the Aluminum Company of America has acquired certain riparian rights in North Carolina and Tennessee, and has undertaken preliminary developments on the Little Tennessee River near the Tennessee-North Carolina boundary. The plans contemplate a water-power development of great magnitude, together with a reduction works at Maryville, 16 miles south of Knoxville.

The consummation of two such projects as those mentioned should prove a tremendous stimulus to the search for new deposits of bauxite in the south.

The Phosphate Deposits of the Southern States: E. H. SELLARDS.

The southern states at the present time are preeminently the source of phosphate rock in the United States, the total rock mined elsewhere in America being not more than 10,000 or 11,000 tons per annum. In fact this section contributes fully one half of the phosphate of the world. The statistics for 1910, the latest date at which approximately complete returns are available show the world's production of phosphate to be 5,156,671 metric tons, of which the United States produced 2,697,468 metric tons, or slightly more than one half, all of which with the exception of 11,612 tons was from the southern states. The production in the southern territory during 1911 was 3,420,774 long tons, while Florida alone in 1912 produced 2,579,865 long tons.

The phosphate deposits in the southern states are widely distributed and are diverse in their origin and manner of occurrence. Those states that are actively producing rock are: Arkansas, Tennessee, South Carolina and Florida. At least five other states, namely, Kentucky, Virginia, North Carolina, Georgia and Alabama are known to have phosphate, or phosphatic marls of agricultural value. The phosphate deposits of North Carolina and Kentucky have been mined to a limited extent. Those of Georgia and Alabama have been partially prospected, while the Virginia phosphates have been but recently discovered.

The methods used in mining the phosphate rock are, as a rule, neither complicated nor expensive. The open pit method is used for those deposits that have a removable overburden, while underground mining is resorted to only for those bedded deposits that are interstratified with other formations so that the overburden can not be removed. The chief production at the present time is from the open pit mines. After being taken from the mine the rock is washed and dried for shipment, almost one half being exported.

The Tennessee Phosphates: T. POOLE MAYNARD.

The phosphate deposits of Tennessee rank next in importance to those of Florida.

These deposits are found in what is known as the Central Basin of Tennessee, and in the valleys of the western part of the Highland rim surrounding this basin. Nodular deposits of black phosphate are found to the northeast of the Highland Rim in Putnam county.

All of the phosphates are found associated with rocks of sedimentary origin and occur in rocks of Ordovician and Devonian age.

There are three important classes of phosphate rock, while there are many characteristic differences among these classes. The brown, the blue and the white phosphate represent the three important classes. While the black rock phosphates of Putnam county are not economically important they form a fourth class.

The Salt Industry of the Southern States: W. C. PHALEN.

The five southern states which produce salt on a commercial scale, named in the order of their importance, are Louisiana, Virginia, Texas, West Virginia and Oklahoma. In the year 1912, the latest for which statistics are available, the output of salt in the states mentioned amounted to

nearly 350,000 short tons, or nearly 2,500,000 barrels, of 280 pounds each, valued in round numbers at $725,000.

In Louisiana salt occurs in two districts, (1) in the north-central and northern part of the state in the valleys of the Red and Sabine rivers, and (2) in the southern part; the most important known deposits, and those worked at present, occurring in close proximity to the gulf coast. Rock salt is the product, mined at Weeks and Avery's islands, so-called, located in Iberia parish, very close to the Gulf of Mexico.

The only economically important deposits of salt found in Virginia occur in the southwest part of the state. These, with the gypsum deposits, extend for twenty miles along the valley of the north fork of the Holston River, and have been developed quite extensively in Smyth and Washington counties. Two gypsum plants and one alkali works, which utilizes the brines, are in operation in this area. Saltville, Smyth county, is the center of the alkali industry.

The important salt industries of Texas are located at Palestine, Anderson county, Grand Saline, Van Zandt county, in the eastern part of the state, and at Colorado, Mitchell county, in the western part. The bulk of the salt marketed in Texas is the evaporated article produced by the grainer process, but considerable also comes from the inland salt lakes in the western part of the state and from the lagoons along the southwestern coast.

In West Virginia the industry is confined to the Ohio River Valley and to the valley of the Kanawha River, a few miles above Charleston, the state capital. The product is evaporated salt produced by the grainer process. Bromine and calcium chloride are also produced on a considerable scale, in connection with the manufacture of salt.

In Oklahoma the salt industry is small, and is confined to the salt plains in the southwestern part of the state.

The Asbestos Deposits of Georgia: Oliver P. Hopkins.

Asbestos representing three modes of occurrence is found in Georgia. Chrysotile, occurring in serpentine derived from peridotite, is present in insignificant quantities in a few localities where it gives no promise of commercial importance. Asbestos of the amphibole variety in slip-fiber veins occurs at widely distributed points over the Piedmont area of the state; while mass-fiber asbestos, which represents the important deposits from a commercial point of view, is restricted, in general, to the belt of peridotites and pyroxenites which cross the state in a southwest direction from Rabun county to Harris county, but is relatively most important in Rabun, White and Habersham counties than any others. Judging from the field relations and the microscopic study, it has been concluded that the mass-fiber anthophyllite has been derived from enstatite-olivine rocks.

Mass-fiber asbestos, owing to the nature of its occurrence, is capable of being mined very economically, but owing to the slight demand for the material little is being put on the market at the present time. With a good demand for the material at from $10 to $12 per ton a number of deposits in this state could be worked at a profit and a large amount of asbestos could be put on the market.

The Production of Fuller's Earth in the Southern States: E. H. Sellards.

Fuller's earth is a clay which has the property of absorbing basic colors and removing these from solution in animal, vegetable and mineral oils, as well as from water and certain other liquids. In commerce the earth finds its chief use in clarifying oils, although it has in addition a number of minor uses.

Fuller's earth, like other clays, is complex and consists not of a single mineral, but of a variety of minerals, the mineral particles being mixed in different earths in widely different proportions, resulting in a varying chemical and mineralogical composition. The ultimate analysis does not differ materially from that of other clays. The properties of the earth arise apparently from the physical condition of the clay and can be detected only by a filtering test by which its practical utility in clarifying oils is determined. Various other properties are assigned to fuller's earth but all, aside from actual bleaching tests, are so variable or are common to such a variety of clays as to be of only secondary value in identifying fuller's earth.

Fuller's earth is mined chiefly by the open pit method, the overburden being removed and the earth dug by pick and shovel. It is then crushed, dried, ground, bolted and sacked for shipment. That intended for clarifying mineral oils is ground to pass 30–60 or a 60–80 mesh sieve while that intended for clarifying edible oils is usually ground to 100 mesh. The action of fuller's earth in clarifying oils is believed to be due chiefly to colloidal silica present in the clay. It is a notable fact that clays suitable for clarifying mineral oils

are in some cases at least unsuited for use on edible oils and the converse is also true. Most fuller's earth gives a taste and odor to edible oils, but it is now known that this can be removed by blowing dry steam through the refined oil heated above the boiling point of water. Some fuller's earths have so rapid an oxidizing effect on edible oils that the mass takes fire when air is blown through to force out the oil remaining in the earth after treatment. This defect in the earth can not at present be remedied.

In the United States fuller's earth was produced during 1912 by seven states. Of these one, Massachusetts, is an eastern state; two, California and Colorado, are western states; and four, Arkansas, Florida, Georgia and Texas, are southern states. The total output of fuller's earth in the United States during 1912 according to the United States Geological Survey was 32,715 tons, all of which with the exception of one or two thousand tons is from the four southern states named, by far the largest part, probably as much as 25,000 tons, being produced in Florida.

The Clay, Brick, Pottery and Bauxite in Tennessee: WILBUR A. NELSON.

A general account of the clay resources of Tennessee, giving the location of ball-clay deposits in west Tennessee, and some recent tests made by the Tennessee Geological Survey. Also a general account of the brick and pottery industry, and a brief description of the bauxite deposits of east Tennessee.

The Tripoli Deposits of Tennessee: L. G. GLENN.

Extensive deposits of tripoli are found in the Watanga shales of the Cambrian. They are the result of the leaching under surface influences of siliceous-argillaceous limestone beds, one of which is some forty feet thick and of very considerable length. The beds, of which six are known, dip at high angles. The depth to which they have weathered is not determined but is known to exceed fifty feet. The material is very similar to the tripoli now marketed for general scouring and polishing purposes.

The Occurrence, Conservation and Utilization of Certain Non-metallic Minerals of the Southern States: JOSEPH HYDE PRATT.

The Iron Ores of the Southern States: WILLIAM B. PHILLIPS.

The Zinc Deposits of Tennessee: A. H. PURDUE.

This paper gives the location of the zinc ores, extent of their area, occurrence and instructions as to prospecting; gives a brief history of zinc mining in Tennessee, with prominent mention of the old Embreeville mine, and also describes the present mining conditions and output.

The Copper Resources of the Southern States: C. H. GORDON.

This paper is an attempt to present briefly the present condition of our knowledge of the copper resources of the southern states.

Copper minerals are of widespread and general occurrence both in geographic position and in geologic age but the deposits of known age that have made important contributions to the country's output can be referred to four periods which in general correspond to periods of igneous activity, viz., the Precambrian periods, the Paleozoic era, the Mesozoic era and the Tertiary period. The chief Appalachian deposits belong to the Paleozoic era and constitute practically all the known deposits referable to this era.

As to their geologic relations the deposits of the southern states may be classed under four groups as follows: (1) Lenticular deposits in schistose rocks. These include mainly deposits of the sulphides of iron, copper and zinc in lenticular bodies in schistose rocks comprising in part altered sedimentary rocks and in part altered igneous masses of basic and acid types. (2) Deposits in fractured and brecciated zones. These include deposits in fissure veins and deposits formed in brecciated zones. (3) Deposits of native copper and cuprite disseminated in igneous rocks. Under this head are grouped deposits in which the copper occurs chiefly in the form of cuprite and native copper distributed along joint planes and crevices, and as disseminated grains in igneous rocks of basaltic type. (4) Disseminated deposits in the Red Beds of the Triassic area. These consist for the most part of films and thin coatings of malachite on joint faces and grains of sulphide and phosphate disseminated through the rock.

The chief deposits of the southern states belong to the first and second classes. Ninety-five and one half per cent. of the production of these states comes from the district of Ducktown in Tennessee. Of the remainder over two thirds is recovered as a by-product in the dressing of the lead ores of Missouri.

Physiographic Conditions that have Contributed to the Making of Atlanta: COLLIER COBB.

A Biological and Physiographic Reconnaissance of the Okefenoke Swamp: J. CHESTER BRADLEY. (Illustrated with colored slides.)

The Development of Some Lake Beds in Florida: E. H. Sellards.

This paper relates to the origin of the basins of the large flat-bottomed lakes found throughout certain parts of interior Florida. These lakes are often of considerable size, although relatively shallow as compared to their areal extent. Moreover they are variable in character. Under normal conditions they are clear water lakes abounding in fish and the favorite haunt of the wild duck. They have, as a rule, no surface outlet, yet from many of them the water has at times disappeared in a manner seemingly inexplicable. Among the largest and best known examples are: Lakes Lamonia, Jackson and Lafayette in Leon county; Miccosukie in Jefferson county; Alligator in Columbia county and Alachua in Alachua county.

These lakes occupy basins which have worked their way down through the surface sands and clays probably of the Alum Bluff formation to or nearly to the underlying limestones which are of either the Chattahoochee or the Vicksburg formations. The beginning of each basin dates from the formation of a sink making an opening through to the underlying limestone, thus diverting the surface drainage to a subterranean course. The small basin resulting from a single sink is enlarged by the formation of additional sinks, this process being promoted by the considerable amount of the surface water that is admitted into the underlying limestone, particularly when the sink has formed in the valley of an existing stream. The depth of the basin is limited by the underground water level since the streams can not well carry away the residual material below this level. As a matter of fact the basins approach but do not quite reach the underground water level.

The ground water level is not stationary but is subject to seasonal and periodic variations, as well as to variation in geologic time. The seasonal fluctuation is due to the variation in rainfall during the wet and dry seasons. The periodic variation is due to the more or less regular periods, often of some years duration, of deficient or of excessive rainfall. The gradual lowering of the underground water level during geologic time, which is due to the downward cutting of stream channels which serve as an outlet, affects the life history although not the observed behavior of the lakes. The seemingly sudden emptying of the lakes is in most cases due actually to the water having gradually run out into the underlying limestone because of the ground water level having been lowered by prolonged drought. New sinks are likely also to form at this time since the lowering of the underground water withdraws the support from the surface materials which are then no longer able to support their own weight and hence break through to cavities in the underlying limestone. These new sinks when formed facilitate the emptying of the lakes.

A New Gypsum Deposit in Iowa: George F. Kay.

In this paper some interesting facts are presented with reference to a gypsum deposit recently discovered at Centerville in southern Iowa. The gypsum is of Mississippian age and is associated with anhydrite. Whether or not the gypsum will prove to be of economic importance has yet to be determined. The evidence indicates that the deposit may be extensive and the gypsum is of good quality. The relation of the anhydrite to the gypsum and the relative amounts of the two minerals will have an important bearing upon the value of the deposit for commercial purposes. The fact that the deposit is more than 500 feet below the surface and the presence of large amounts of artesian waters are factors unfavorable to the mining of the gypsum. On the other hand, the deposit is well located with regard to fuel and transportation, and it is fair to assume that if gypsum products were made in this part of the state a good market for such products could soon be developed.

The Development of Some Underground Streams: Edgar H. Webster.

A Comparison of the Ordovician Section of Southwest Virginia, with that of New York: S. L. Powell.

In view of statements not infrequently made to the effect that the Ordovician of Virginia and the South in general can not be correlated with the New York section, and in view of the fact that in southwest Virginia, in the vicinity of Salem, there occurs a continuous, unbroken section of Ordovician strata about four thousand feet in vertical thickness, very favorably disposed for observation, and as the locality is intermediate between the extremes heretofore most carefully studied, detailed work was undertaken for purposes of comparison with the standard sections north.

The results show that the correlation can be made, and that in almost every detail, including the divisions of the Beekmantown (Calciferous) established by Brainerd and Seely of Vermont. Without going into detail here, the main difference

in the Ordovician is at the top and near the bottom of the section. The alternating red and greenish yellow shales and sandstones (Bays) just beneath the Medina sandstone, occupying the position of the Juniata in the north, are here very fossiliferous, whereas in Pennsylvania and New York they are practically barren of life forms. Here it carries Orthoceratites, Gasteropods, Brachiopods, etc., in great abundance. The stratum here measures about eighty feet whereas in the north it is several hundred feet thick. The Hudson River is virtually the same as north. Just above the Trenton, however, occurs a heavy stratum of alternating sandstone and shale, Tellico of the south. The upper Trenton is massive rather impure light blue limestone, passing into thin bedded dark to black limestone with some shales intervening. The middle Trenton is characterized by a development of several hundred feet of black shale (Athens Shale) carrying Trilobites and many forms of Graptolites, among which are the whorled type described by Ruedemann from northeastern New York. This is followed by the Black River limestone, identical in almost every respect, lithologically as well as in fossil content, with that of New York. The same is true for the Birdseye beneath. The Birdseye terminates in a six-foot stratum of brecciated conglomerate, with fragments of limestone and chert ranging in size from one half inch to fifteen inches in diameter. The Chazy, which follows, agrees in its lithology and fossil content with that of Vermont, terminating in a ferruginous sandstone, which corresponds in position and character with the Isle La Motte sandstone.

Detailed work in the Beekmantown below has not as yet been completed, but thus far the divisions established by Brainerd and Seely of Vermont with their characteristic boundaries and fossils are believed to have been identified.

The "Undagraph," Its Use for the Study of Microseisms: OTTO KLOTZ. (Illustrated.)

Recent Backward Extension of the Life Record in Geologic Time: CHARLES KEYES.

The differentiation of life on our globe prior to the stage represented by the *Olenellus*, or Early Cambrian, zone, the oldest phase with which we have been acquainted, has lately passed from the realm of pure speculation to that of direct observation. The wide interest aroused by these recent discoveries of abundant well-preserved organic remains in rocks of undoubted pre-Cambrian, and hence pre-Paleozoic, age is secondary only to the enthusiasm produced a few months ago by the actual location of the fossiliferous horizons in the general geological column. As definitely determined these oldest fossil-bearing levels are stratigraphically more than two miles beneath all other known horizons yielding traces of life. The revelations, of course, materially modify all our previous notions on the subject. They open up a more inviting field of investigation than awaited paleontologists when the Paleozoics first revealed their secrets. Between the bottom of the Paleozoics and the old Azoic gneisses, as usually represented in the text-books of the science, we may now insert the complete schemes of two great fossiliferous successions each of greater stratigraphic and taxonomic importance than that of the entire Paleozoic sequence as now known.

Fauna of the Pleistocene Asphalt Beds at Rancho La Brea, California: J. C. MERRIAM. (Illustrated.)

Tertiary of the Great Basin Region: J. C. MERRIAM.

The Clinton-Niagara Sand Reefs, Dune Ridges and Lagoons—Bordering the Paleozoic Sea: COLLIER COBB.

GEORGE F. KAY,
Secretary

ATLANTA MEETING OF SECTION G

AT 2 P.M., Tuesday, December 30, the meeting of Section G was called to order by the chairman, Professor H. C. Cowles. In the absence of the secretary, Professor W. J. G. Land was made secretary *pro tem.* The following officers were elected. For member of the sectional committee for five years, Dr. D. T. MacDougal; for member of the council, Dr. C. Stuart Gager; for member of the general committee, Professor D. M. Mottier.

The Sectional Committee recommended and the association elected Professor G. P. Clinton, of New Haven, as vice-president and chairman for the Philadelphia meeting.

The following papers were read:

"The Evolution of a Botanical Problem: The Discovery of Sexuality in Plants," address of the retiring Vice-president, Duncan S. Johnson.

"The Water Requirements of Plants," by Lyman J. Briggs and H. L. Shantz.

"Samoan Vegetation," by W. J. G. Land.

W. J. V. OSTERHOUT,
Secretary

SOCIETIES AND ACADEMIES

THE NEW ORLEANS ACADEMY OF SCIENCES

THE regular monthly meeting of the Academy was held at Tulane University, on Tuesday, January 20. Dr. Isadore Dyer, the president, presided and there was a large attendance of fellows and members.

The subjects of the meeting were: (1) a paper on "The Passive State of Metals," by Dr. B. P. Caldwell, professor of chemistry at Tulane. The speaker reviewed the different theories which have been brought forward to account for the facts of passivity from the time of Keir to the present, pointing out the facts in support of, and in opposition to, each theory. He also called attention to certain especially peculiar phenomena attendant upon the processes of passivating and activating, and in closing pointed out the industrial importance of scientific study of the problem of making iron and metals in general more resistant to corrosion.

The second paper was read by Dr. W. L. Owen, of the United States Bureau of Agriculture, upon the problem of the maintenance of soil fertility. The speaker brought out the fact that the problem seemed much more complex to-day than it did when Liebig made his celebrated contribution to the subject. The problem of the future, according to the speaker, will concern itself more with the detection of soil toxines and the best means of stimulating the various groups of soil bacteria than in the increased use of commercial fertilizers.

There was some discussion at the conclusion of these papers, in which Drs. Gustav Mann, C. C. Bass and J. H. Clo and other speakers participated.

R. S. COCKS,
Secretary

THE BOTANICAL SOCIETY OF WASHINGTON

THE ninety-fourth regular meeting of the Botanical Society of Washington was held in the Assembly Hall of the Cosmos Club, at 8 P.M., Tuesday, February 3, 1914. Messrs. Raymond B. Wilcox, Arno Viehoever and Henry Pittier were elected to membership.

The scientific program was as follows:

Brief notes and Reviews of Literature.

Dr. David Griffiths reviewed a prospectus of a stock company which has been organized in Australia for the purpose of eradicating the cactus, which is there considered a serious pest.

Mr. S. C. Stuntz called attention to the return from Brazil of Mr. A. D. Shamel, who has been there with Messrs. Dorsett and Poponoe, who are studying methods of tropical fruit culture and introducing the varieties that may be of value in this country. Mr. Shamel brought back over 1,100 photographs which have thus far been taken by them, and prints of these will soon be available for study at the Office of Foreign Seed and Plant Introduction for those who are interested.

A Report on the Atlanta Meeting of the Botanical Society of America: DR. R. H. TRUE.

Dr. True gave a report on the attendance at the meetings and number and character of the papers read before the different sections, with special notes regarding those of a botanical character.

The Relation Between Transpiration and the Absorption of Inorganic Constituents by Plants: DR. H. HASSELBRING.

Published in *Bot. Gaz.*, 57: 72–73, January, 1914.

A Fertile Hybrid Between Tripsacum and Euchlæna: G. N. COLLINS. (With lantern.)

To be published in the *Journal of the Washington Academy.*

An Attempt at Revegetation on Kodiak Island, Alaska: DR. WALTER H. EVANS.

The conditions on Kodiak Island following the eruption of Mt. Katmai in May, 1912, were described and an account was given of experiments in restoring the meadows and pastures of the experiment station on that island.

The level land was covered with the ash, or, more correctly, the débris from the explosion, to a depth of 12 to 14 inches, and practically all vegetation was destroyed. The only natural revegetation was where hummocks of earth brought the original soil nearer the surface or where plants came through cracks that formed in the deposit during the summer season. In these places fireweed, *Epilobium angustifolium,* and Alaskan redtop, *Calamagrostis langsdorfii,* have come up quite abundantly.

In gardens and wherever an especial effort was made to mix the deposit with the underlying soil, better growth was reported than normal, the ash appearing to have been of benefit, probably by reason of the improved physical condition of the soil.

P. L. RICKER,
Corresponding Secretary